Project WIND
Phase IV, Dispersion Study: AMADEUS

Risø–M–2861

Aerial Smoke Plume Observations and Surface-Layer Turbulence Measurements. Part II: Wind and Temperature Spectral Analysis

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Abstract This data report contains results from selected time series and spectral analyses of the turbulent wind and temperature measurements performed by Risø National Laboratory during the AMADEUS "Smoke and Diffusion Tests" of Project WIND, Phase IV, which took place as a cooperative research oriented study between the U.S. Army Atmospheric Sciences Laboratory (ASL) and U.S. Department of Agricultural Forest Service (USDAFS) in the Meadow Brook Valley near Read Bluff, California, during the period between 3 September and 7 October 1987.

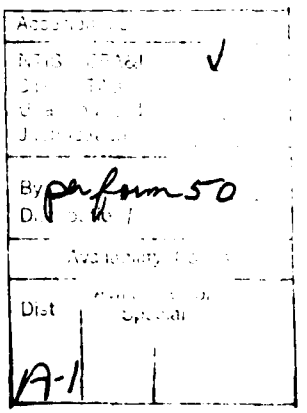
In Part I of this study (Risø– M–2718, January 1989), Risø National Laboratory reported sonic-anemometer measurements of 10-min averaged surface-layer scaling parameters such as surface heat flux, shear stress, turbulence levels and atmospheric stability measured at two locations in the Meadow Brook Valley floor accompanied by aerial photography of the valley-floor smoke puff and plume spread.

The present study (Risø–M–2861) provides time series plots of the turbulent (10 Hz block-averaged) wind and temperature signals as recorded by sonic-anemometers/thermometers at the 7-m level above the Meadow Brook Valley floor during the AMADEUS trials. The time series are further processed into energy spectra for the three wind components (u', v', w') and fluctuating temperature (T') and here presented together with their relevant scaling parameters calculated by the correlation method.

The time series and spectra provide flow and diffusion modellers of the AMADEUS experiments with an insight in the turbulent scales and energies most responsible for the observed flow and diffusion processes. Furthermore they provide high-resolution boundary-layer flow and turbulence measurements for model simulation of the individual experiments.

All data have been transferred to ALS on IBM PC-compatible diskettes.

The work was performed under Contract No. DAJA45–88–M–0325 with the U.S. Army Research, Development and Standardization Group – U.K. under supervision of Chief, Environmental Sciences Branch, Mr. J.C. Comati.



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Contents

1 Introduction

1.1 Measurements

Besides on-line computer-system calculating the 10 min mean statistics of shear stress, heat flux, variances etc. based on the four sonic signals as described in part I, additional (high-frequency) analog recording of these signals were taken from the central-valley located "sonic B" during a total number of 14 diffusion tests, with the purpose of performing time series and spectral analyses of the surface-layer turbulence quantities.

Table 1. AMADEUS 1987 sonic spectra

Speed: 2.38 cm/s ch 1 ch 2 (u) (v) 10 m/s 10 m/s	(15/16) ch 3 (w) 2 m/s	(max 8 hrs) ch 5 (T) 5°C /Volt	AMADEUS 1987 Sonic Spectra			
FM - tape	Date		Start	Stop	Duration	Spectra
# 1	23 Sep		11:00	15:57	4 hrs 57 min	14:00 - 15:32
# 2	24 Sep		21:05	05:07	8 hrs 08 min	23:45 - 01:17
# 4	26 Sep		10:30	13:32	3 hrs 02 min	12:00 - 13:32
# 5	27 Sep		06:15	12:15	6 hrs 00 min	06:15 - 07:47
# 6	28 Sep		10:20	14:52	4 hrs 32 min	10:20 - 11:52
# 7	30 Sep		06:22	14:30	8 hrs 08 min	06:32 - 08:04
# 8	30 Sep		17:35	01:43	8 hrs 08 min	19:25 - 20:57
# 9	01 Oct		06:32	14:42	8 hrs 10 min	06:32 - 08:04
# 10	01 Oct		06:32	14:42	8 hrs 10 min	13:10 - 14:42
# 11	02 Oct		06:40	13:20	6 hrs 40 min	06:40 - 08:12
# 12	02 Oct		06:40	13:20	6 hrs 40 min	11:48 - 13:20
# 13	03 Oct		06:40	12:34	5 hrs 54 min	06:40 - 08:12
# 14	03 Oct		14:10	22:18	8 hrs 08 min	19:30 - 21:02

2 Data Analysis

2.1 Selection of runs

An overview of the 14 diffusion tests is given in table 1.

2.2 Digitizing, block averaging and time series plots

In the first step, the four raw sonic signals from each experiment were digitized at our laboratory at a rat eof 10 Hz and calibrated into physical units of wind speeds U, V, and temperature T.

Secondly, each raw data series was examined and quality assured before a sequence of approximately 92 minutes (55,000 scans) was selected for further analysis, comprising the following steps.

1. Calculation of the U, V and W mean values followed by a rotation, first around the y-axis, next around the z-axis of the anemometer, in order to obtain externally aligned data series in which the mean values $\langle V \rangle$ and $\langle W \rangle$ are equal to zero.

2. Calculation of the symmetric covariance matrix of fluctuating quantities:

$$\begin{array}{cccc} \langle uu \rangle & \langle uv \rangle & \langle uw \rangle & \langle ut \rangle \\ & \langle vv \rangle & \langle vw \rangle & \langle vt \rangle \\ & & \langle ww \rangle & \langle wt \rangle \\ & & & \langle tt \rangle \end{array}$$

   based on the entire 92-min aligned subset of approximately 55,000 scans where $u = U - \langle U \rangle$, $v = V - \langle V \rangle$, $w = W - \langle W \rangle$ and $t = T - \langle T \rangle$.

3. High-resolution time series plots were made of the aligned three-wind components and temperature signal for inspection.

2.3 Spectral analysis: velocity and temperature spectra

From each experiment, consisting of some 55,000 measurements of U, V, W and T, five to six segments of equal length of 2^{13} (8192 scans, euqal to 819.2 sec) data points were selected. These were in turn individually Fourier transformed into 4094 spectral power values, ranging in frequency approximately 3.6 decades from 1/819.2 Hz, 2/819.2 Hz, 3/819.2 Hz 4/ ... up to the 5 Hz Nyquist frequency.

Subsequently, these five to six power spectra were ensemble averaged and additionally smoothed with a 20 percent relative bandwidth filter before plotting.

2.4 High-resolution time series plots of one-min running mean values

Running mean caluclations of variance and important fluxes (heat flux and shear stress) were performed. In addition to the covariance matrices of U, V, W, T based on the entire "run" (55,000 scans), we also calculated the one-min running mean

of the vertical variance $\langle ww \rangle$ along the wind stress component $\langle uw \rangle$ and the heat flux $\langle wT \rangle$. We used a "box-car" filter function, i.e. we calculated $\langle ww \rangle$, $\langle uw \rangle$ and $\langle wt \rangle$ at each time increment (0.2 sec) based on the last 300 scans (one-min worth of data) and plotted also the result versus time in a high-resolution time series plot that can be compared with the aligned measurements of U, V, W and T. These plots are extremely valuable for the interpretation of the bulk fluxes measured. They show whether a measured 10-min or 92-min bulk flux can be attributed to a single event, a few events, or whether the measured quantity is evenly distributed over the experiment.

3 Presentation of data

Next the results of the individual experiments are presented. Each experiment is represented by two tables and five figures in the following way.

3.1 Tables and figure legends

First page:

Log book table for run # N
The log book table shows date of experiment, start and stop time for the FM tape recorder and time period selected for times eries and spectral analys.

Second page

10-min mean values for run # N
Figures of the variation of the 10-min averaged surface layer scaling parameters of

1. mean wind speed
2. mean direction
3. mean temperature
4. total energy
5. stress
6. heat flux
7. stability parameter (z/L).

These figures have already been presented in part I but here they are reproduced with the selected periods of time series and spectral analysis marked (shaded periods).

Third page

Sonic time series
Some 55,000 values of the 10 Hz digitized wind components (U, V, W) are shown after calibration and alignment ($\langle V \rangle = \langle W \rangle = 0.0$), together with the temperature signal T. The scales are U and $V : \pm 10$ m/s; $W : \pm 5$ m/s, and $T0 - 10K$. The mean temperature $\langle T \rangle$ is arbitrarily offsett from plot to plot (in order to obtain full resolution during recording and digitizing).

Fourth page

Mean statistics for time series

The table shows the mean and covariance statistics calculated for the *entire* diffusion tet period, with a typical duration of 92 minutes (55.000 scans), to be considered as an alternative "overall" average of the 10-min by 10-min statistics for the same period preented in part I (see "second page" above).

Fifth page

Wind speed (U-component) and one-min running mean statistics of vertical variance $\langle ww \rangle$, shear stress $\langle uw \rangle$, and heat flux $\langle wT \rangle$

The first time series plot out of four is a reproduction of the U-component (see "third" page above), but augmented here in scale (−2 m/s to +8 m/s). It has been included again for "event" marking and interpretation.

The second trace shows the one-min running mean value of the vertical velocity variance $\langle ww \rangle$. The scale is from 0.0 to 1.0 [mm/ss].

The third trace is the one-min running mean value of the stress component $\langle uw \rangle$. The scale is from −1.00 to +1.00 [mm/ss].

The fourth and last trace shows the one-min running mean value of the vertical heat flux $\langle wT \rangle$. The scale is from −0.5 to +0.5 [m/s K]. When multiplying by approximately 1200 ($\rho_* C_p$), this figure shows the heat flux in Watts/m^2 in the interval between −600 and +600 [Watt/m^2].

Sixth page

Velocity (u, v and w) spectra for run # N

The figure shows the three velocity spectra calculated as described above. The abscissa ranges from 0.001 to 10 Hz in frequency, the Nyquist frequency is 5 Hz. The ordinate shows the spectral density $fS(f)$ in the interval between 0.0001 to 1.0 [mm/ss]. The lowest spectral estimate is at 1/819.2 Hz, cf above.

Seventh and last page

Spectrum of fluctuating temperature for run # N

The figure shows the temperature spectrum in the same as for the previous figure (velocity spectra). Here, however, the ordinate has the dimension [K^2].

4 Results

4.1 Run # 1, 23 September, overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1 ch 2 ch 3 ch 5							
(u) (v) (w) (T)							
10 m/s 10 m/s 2 m/s 5°C /Volt							
FM - tape		Date		Start	Stop	Duration	Spectra
# 1		23 Sep		11:00	15:57	4 hrs 57 min	14:00 - 15:32

Run # 1

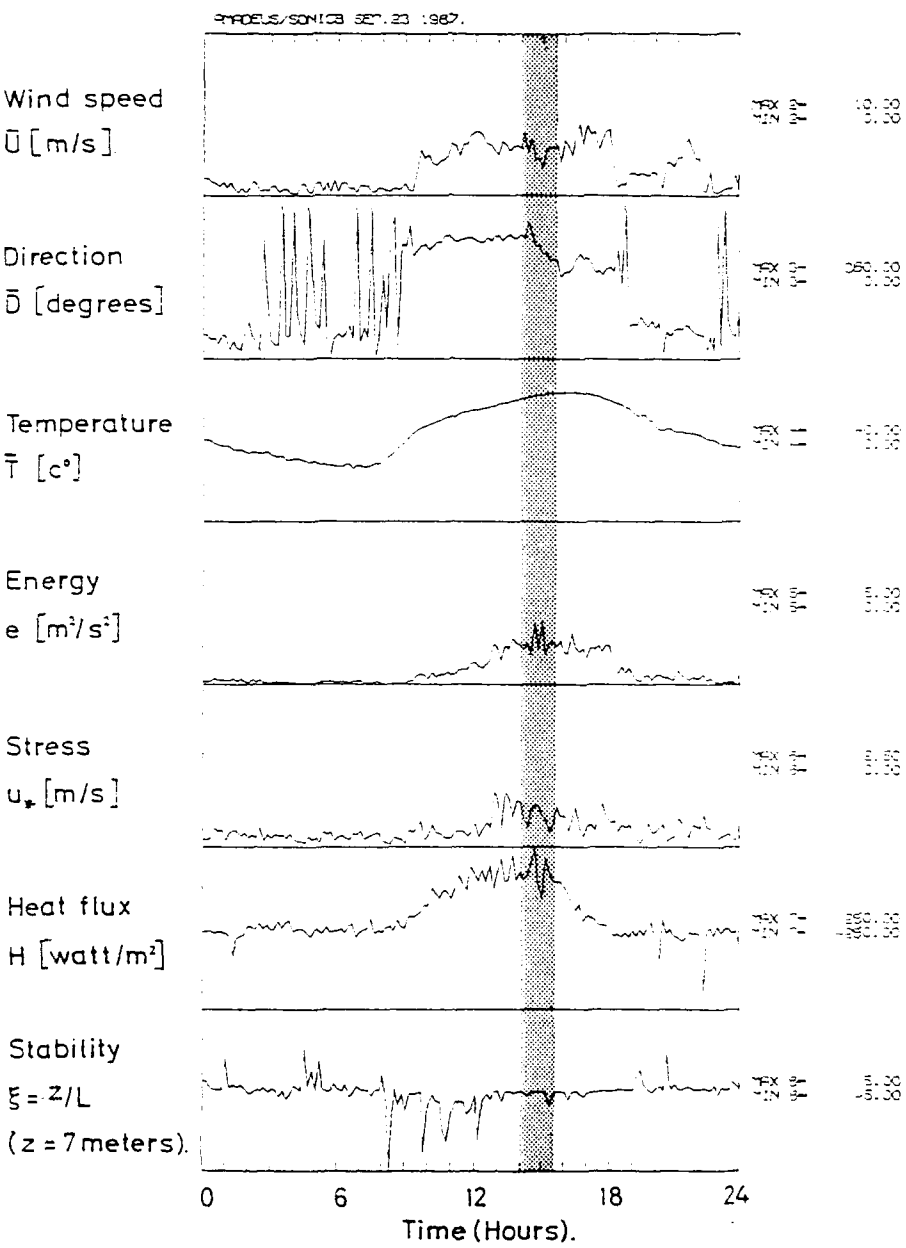

Figure 1: 10-min mean values for Run # 1.

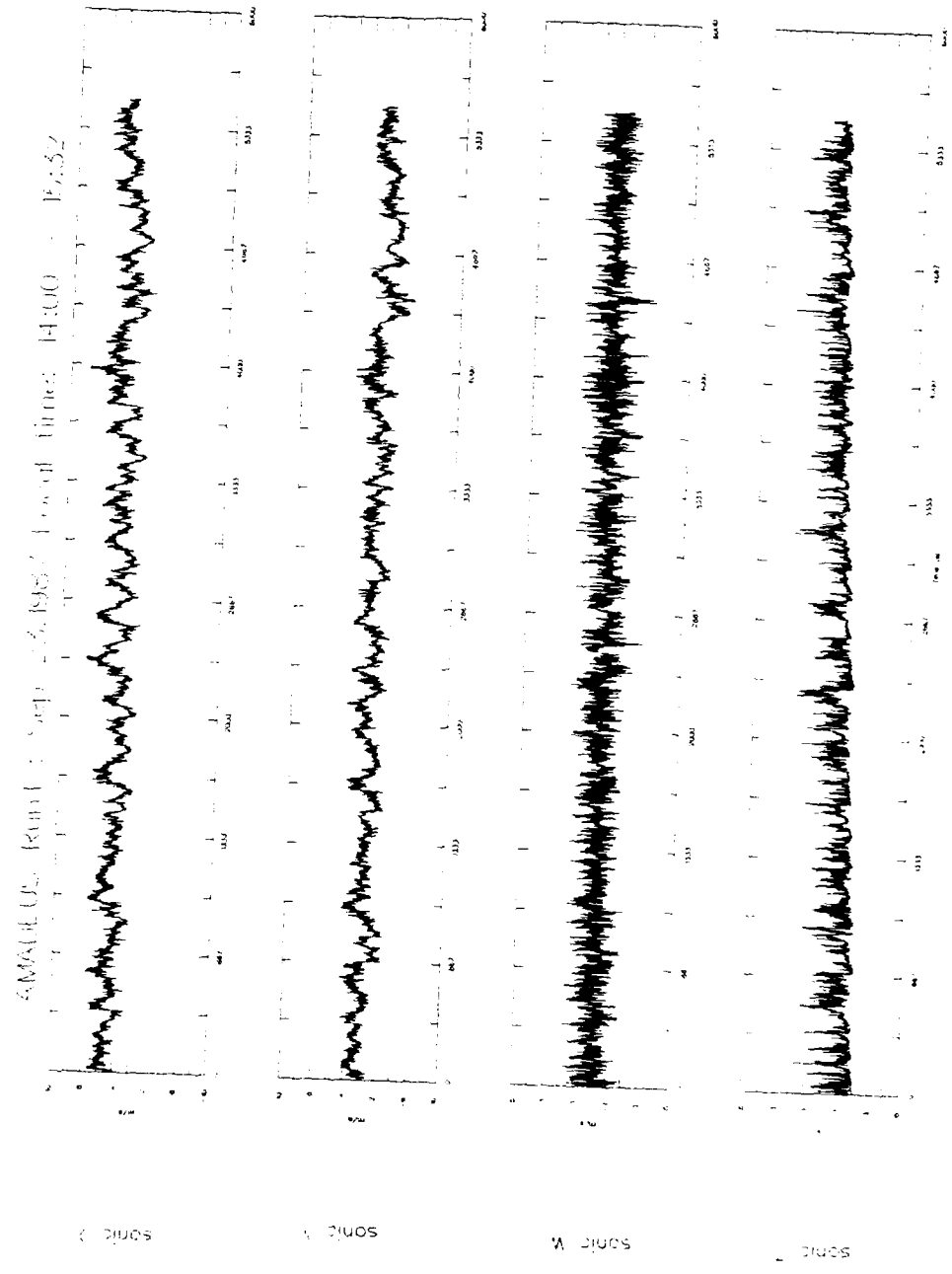

Figure 2: Sonic time series.

Table 2. Mean statistics for time series

	Run # 1 - Statistics from 55000 samples							
Mean	u :	3.012	v :	0.000	w :	-0.000		
Covariance	uu	1.28777	uv :	0.50138	uw :	-0.05309	uT :	-0.05874
			vv :	1.03439	vw :	0.05124	vT :	-0.13387
					ww :	0.30186	wT :	0.15703
							TT :	0.57997

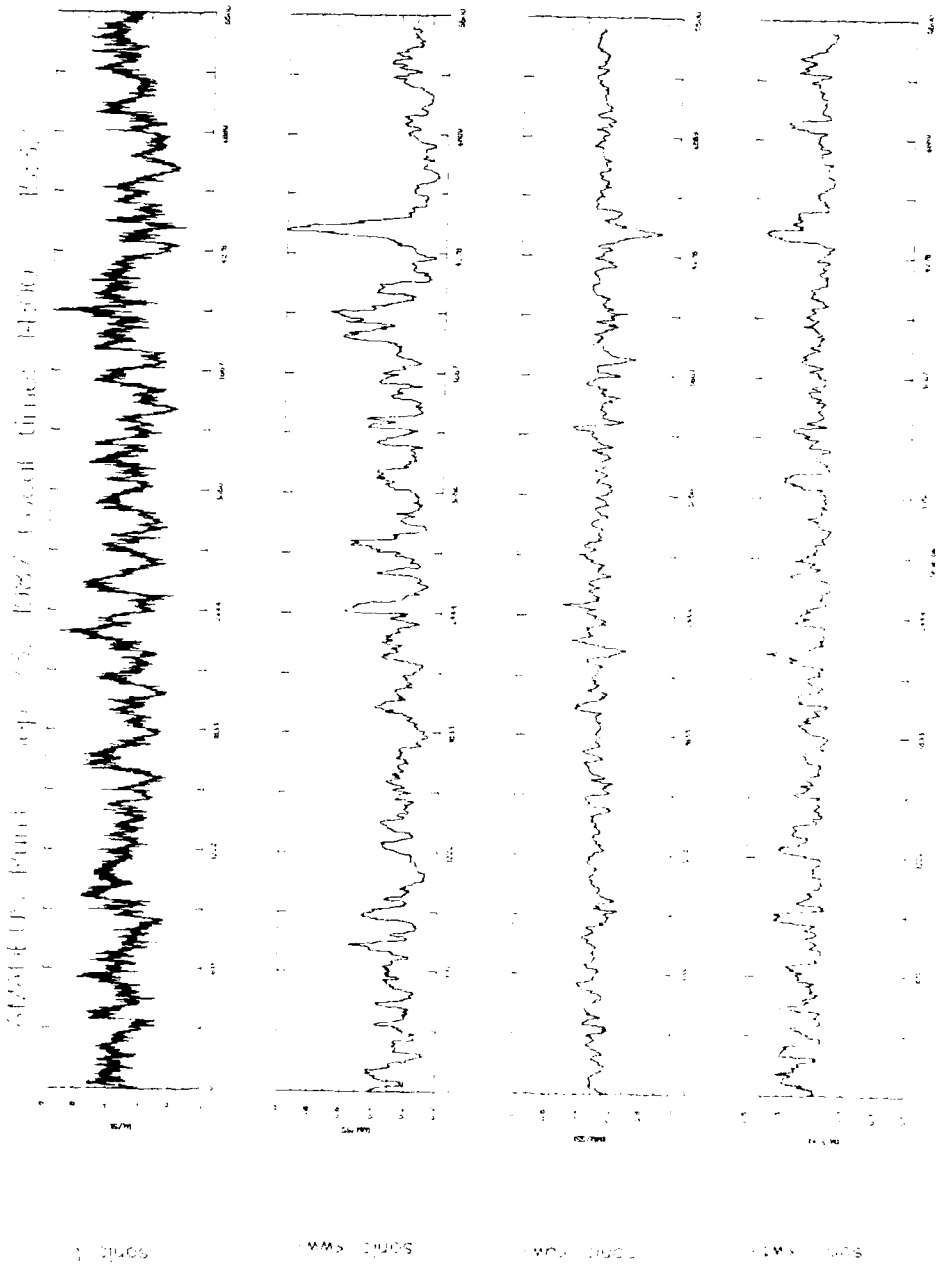

Figure 3: Wind speed (u) and 1-min running mean statistics of vertical variance ($\overline{ww}$), shear stress ($\overline{uw}$), and (sensible) heat flux ($\overline{wt}$).

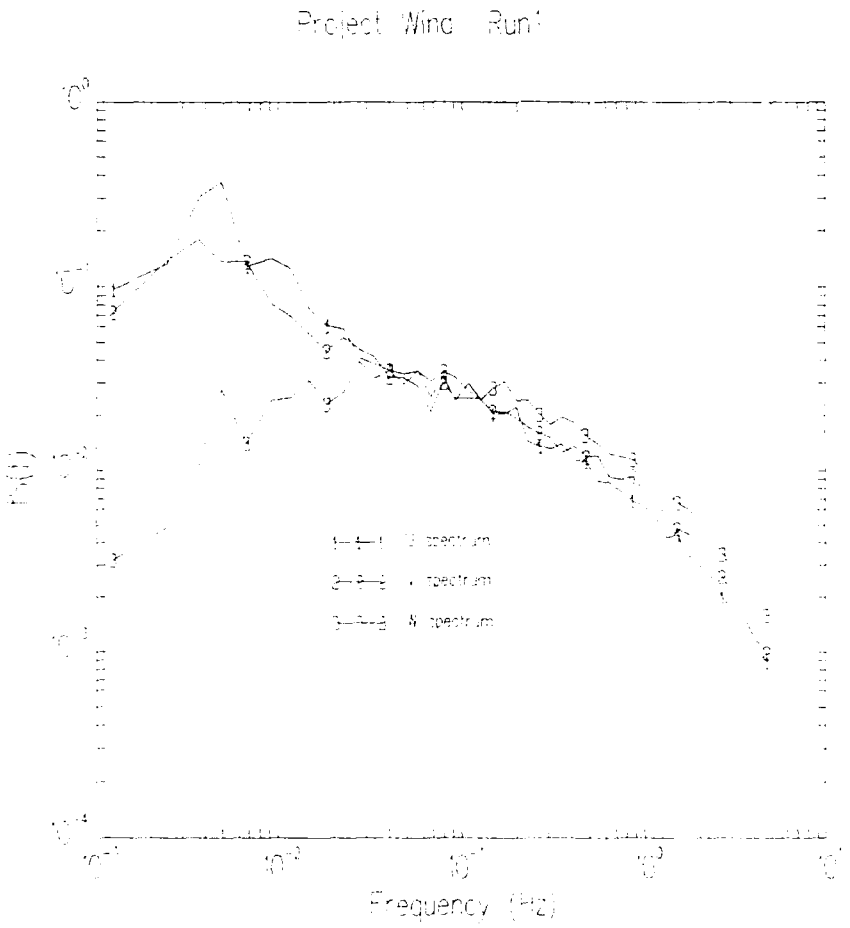

Figure 4: u,v and w-spectra for Run # 1.

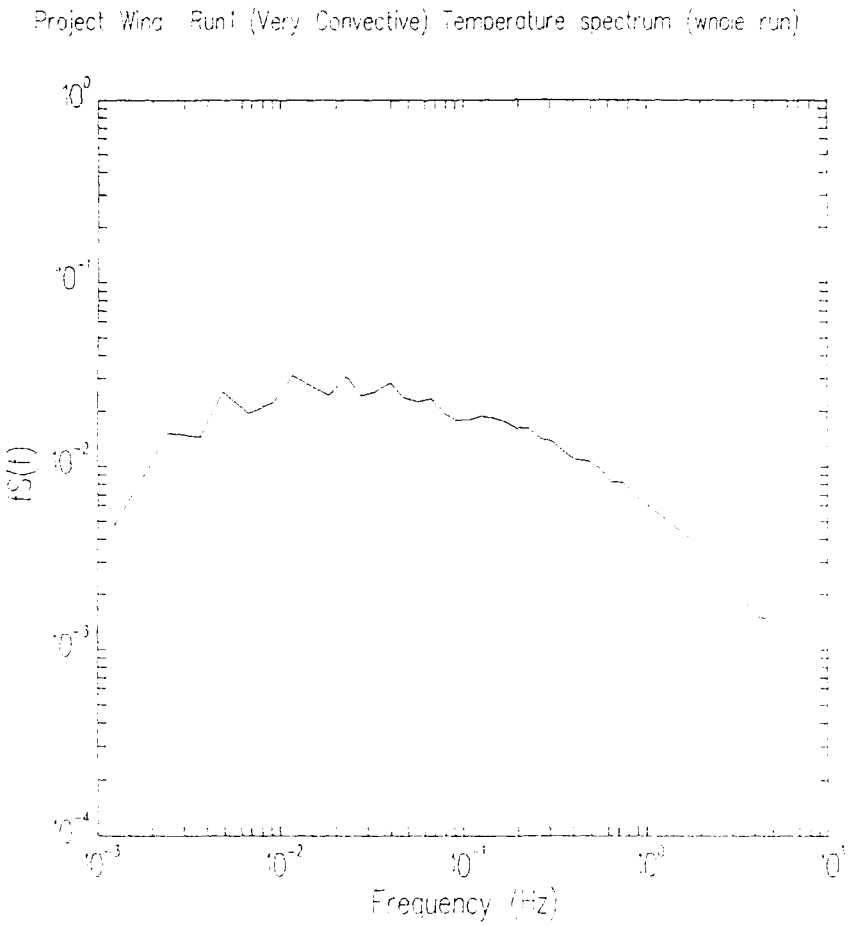

Figure 5: Temperature spectrum for Run # 1.

4.2 Run # 2, 24 September, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1	ch 2	ch 3	ch 5				
(u)	(v)	(w)	(T)				
10 m/s	10 m/s	2 m/s	5°C /Volt				
FM - tape		Date		Start	Stop	Duration	Spectra
# 2		24 Sep		21:05	05:07	8 hrs 08 min	23:45 - 01:17

Run # 2

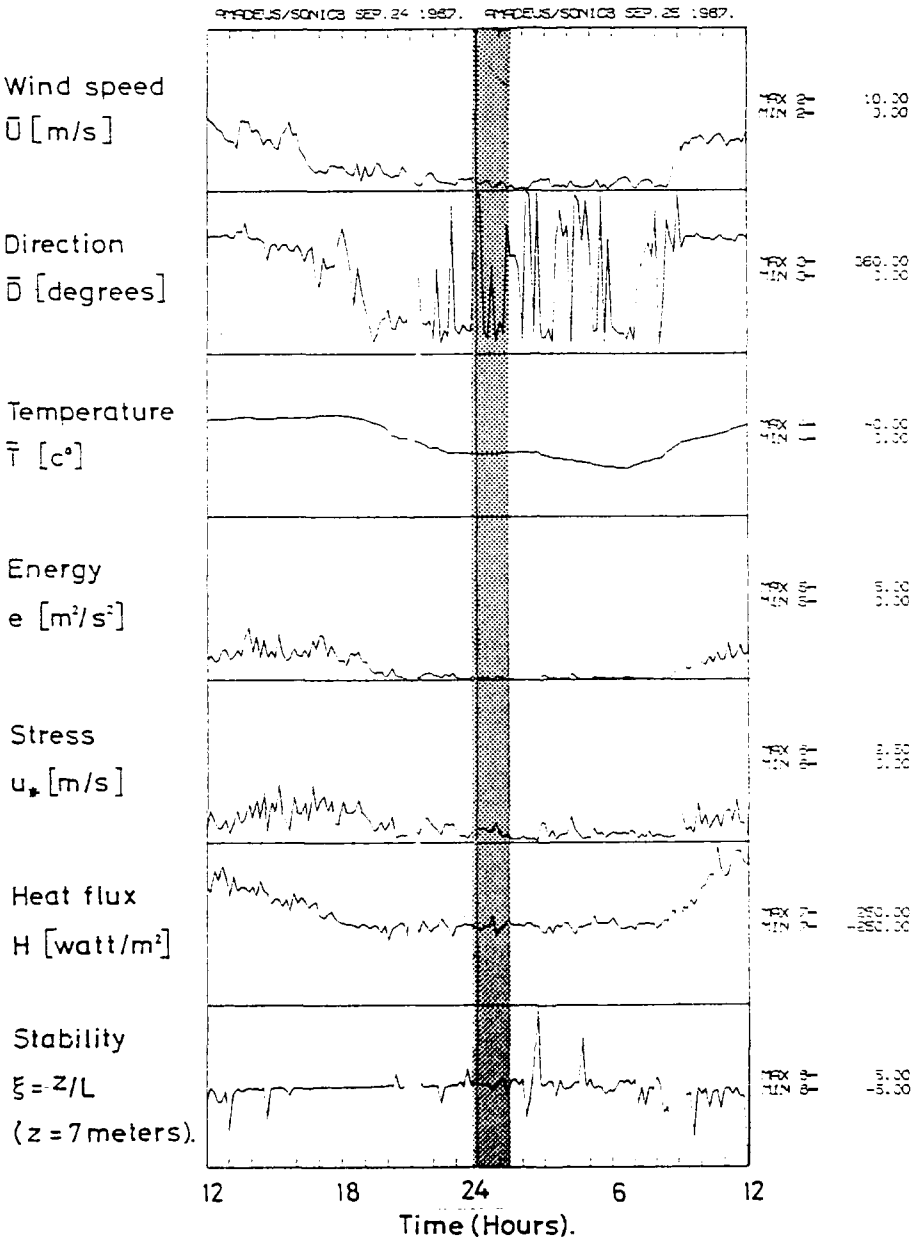

Figure 6: 10-min mean values for Run # 2.

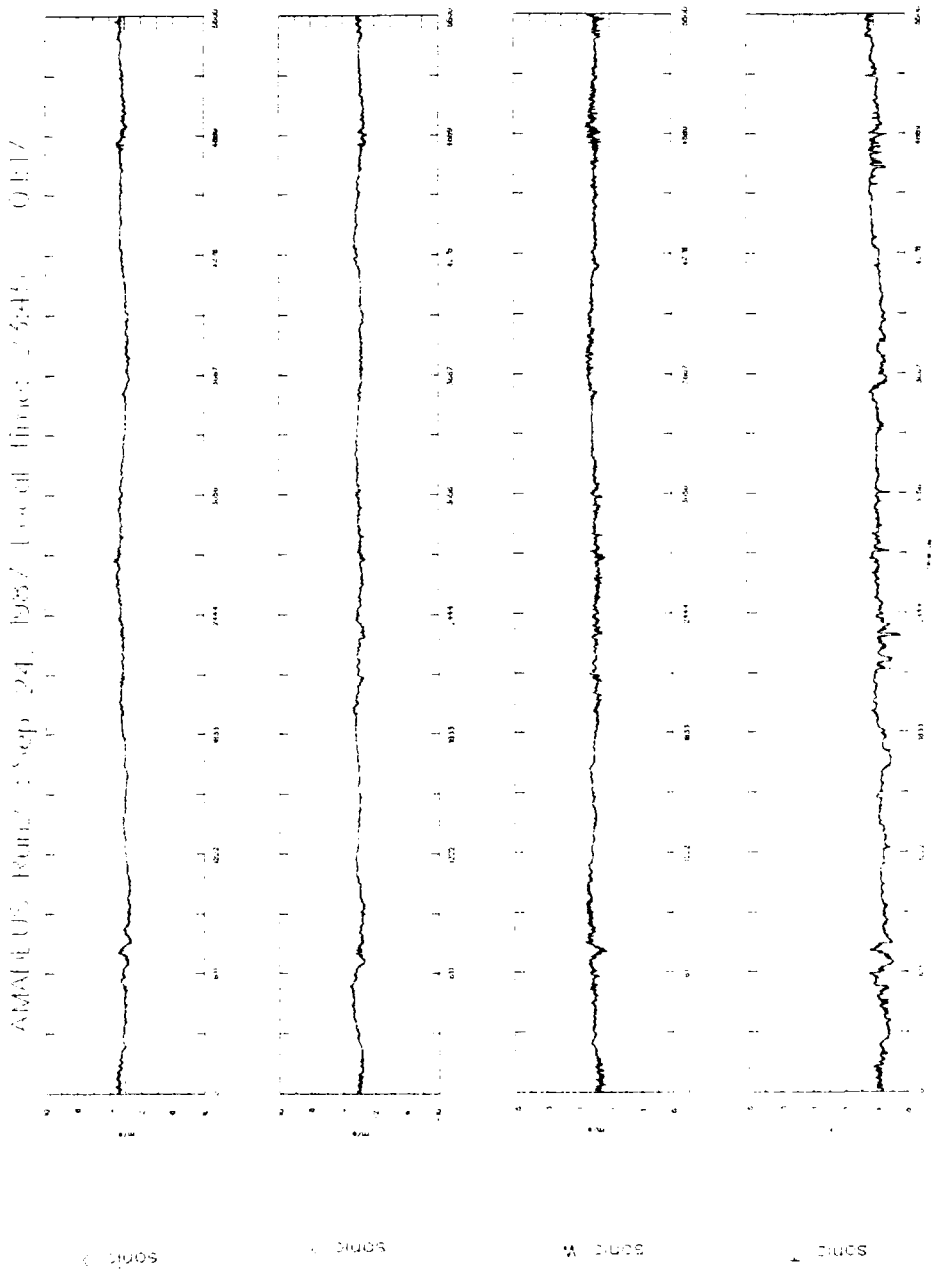

Figure 7: Sonic time series.

Table 3. Mean statistics for time series

	Statistics from 55200 samples							
Mean	u :	0.279	v :	0.000	w :	0.000		
Covariance	uu	0.13239	uv :	0.01034	uw :	-0.05721	uT :	0.06050
			vv :	0.10501	vw :	-0.00519	vT :	0.00889
					ww :	0.03387	wT :	-0.02677
							TT :	0.08506

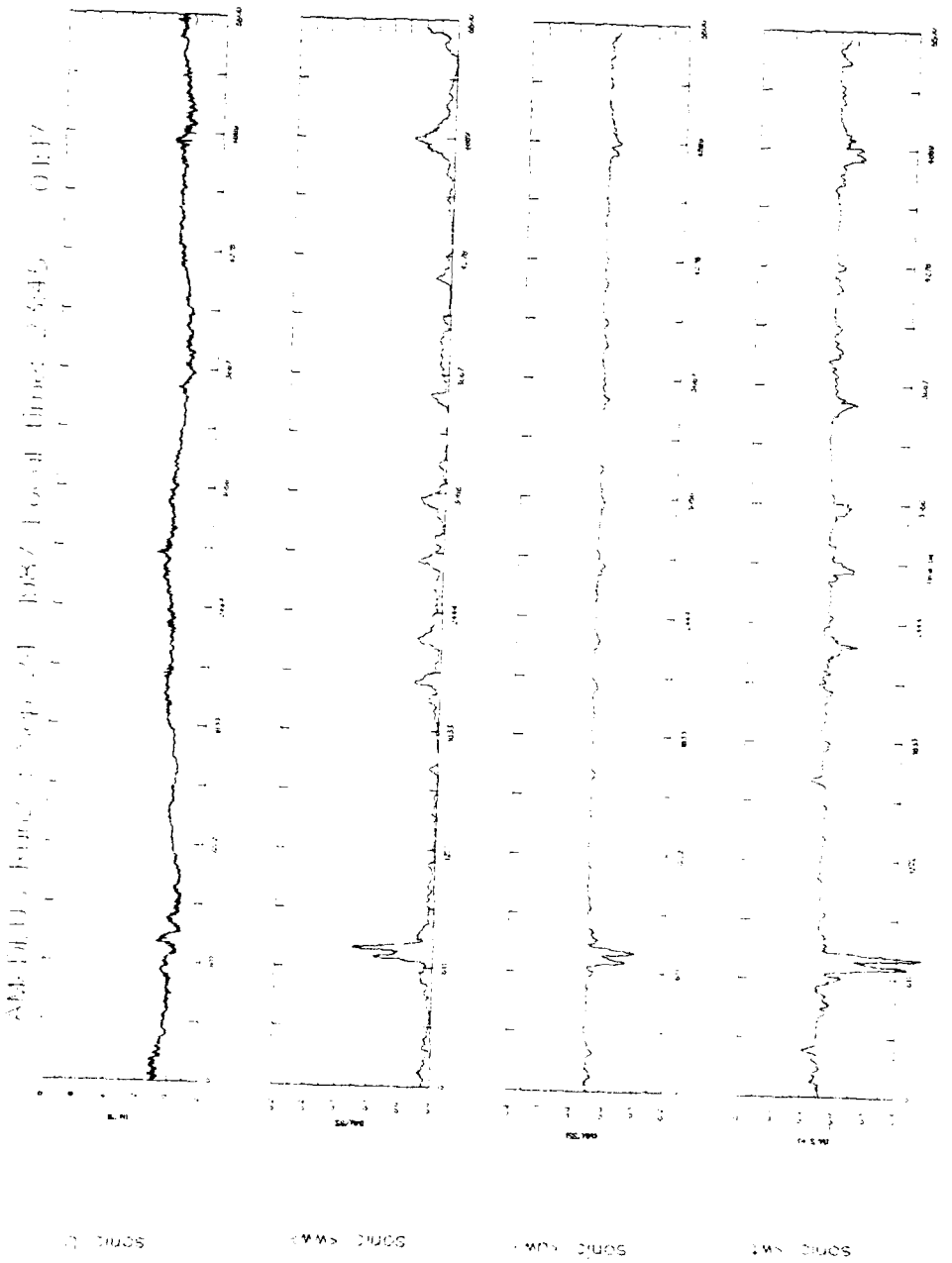

Figure 8: Wind speed (u) and 1-min running mean statistics of vertical variance ⟨ww⟩, shear stress ⟨uw⟩, and (sensible) heat flux ⟨wt⟩.

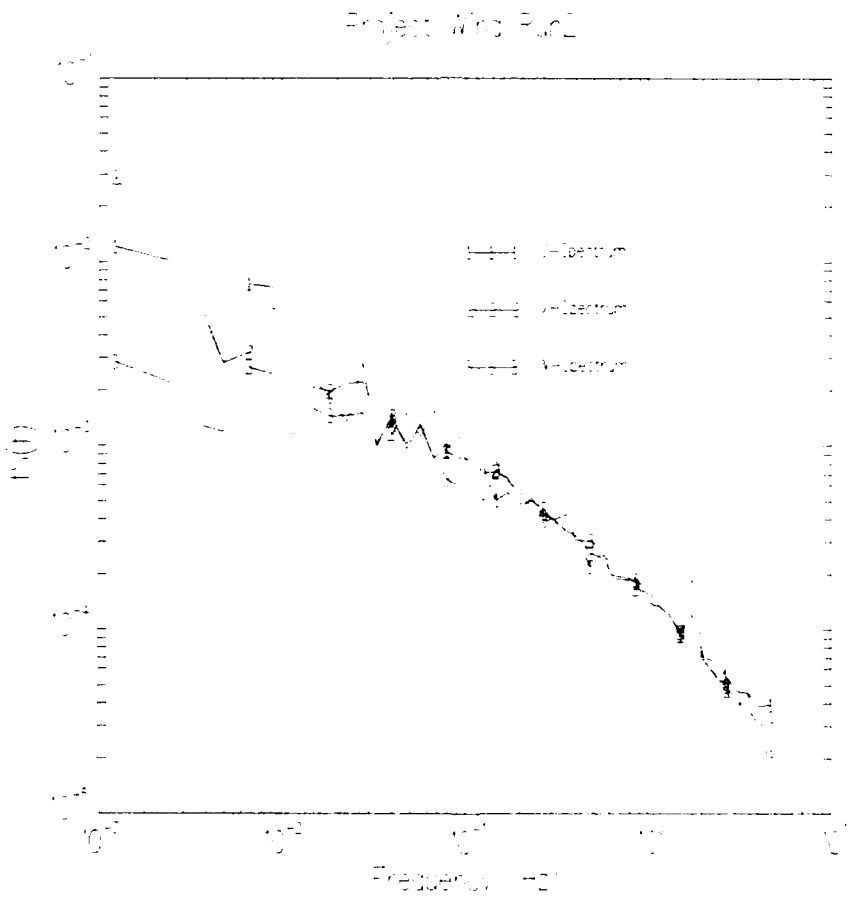

Figure 9: u, v and w-spectra for Run # 2.

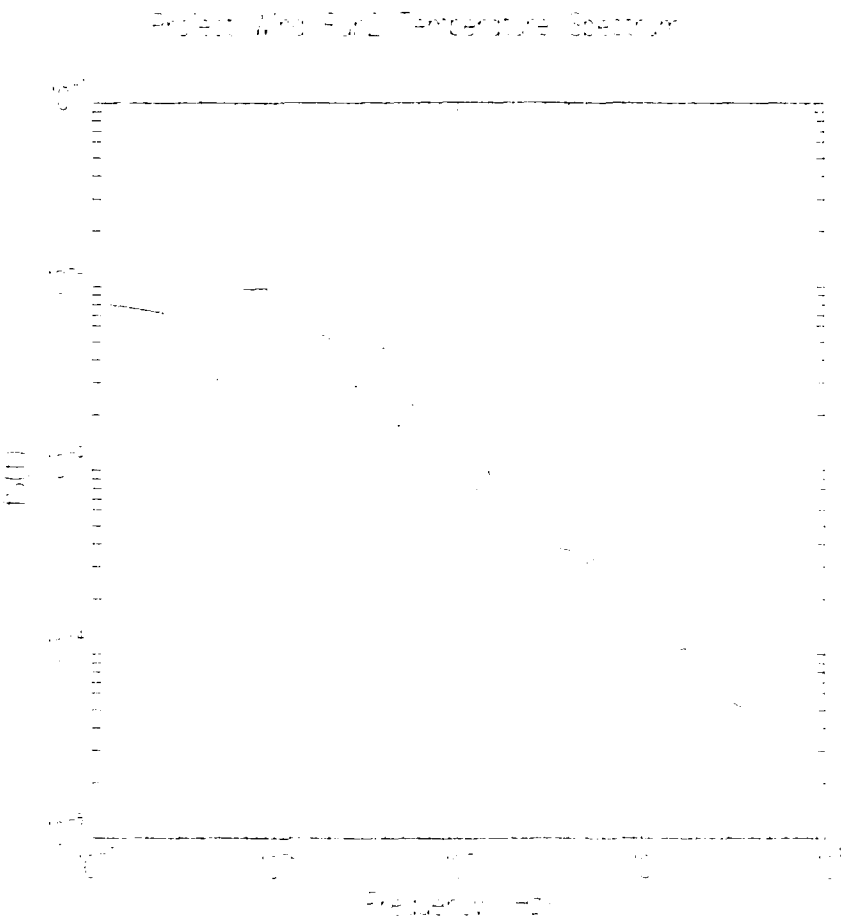

Figure 10: Temperature spectrum for Run # 2.

4.3 Run # 3, 25 September, experiment cancelled – no smoke

4.4 Run # 4, 26 September, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs) ch 1 ch 2 ch 3 ch 5 (u) (v) (w) (T) 10 m/s 10 m/s 2 m/s 5°C /Volt				AMADEUS 1987 Sonic Spectra			
FM - tape		Date		Start	Stop	Duration	Spectra
# 4		26 Sep		10:30	13:32	3 hrs 02 min	12:00 - 13:32

Run # 4

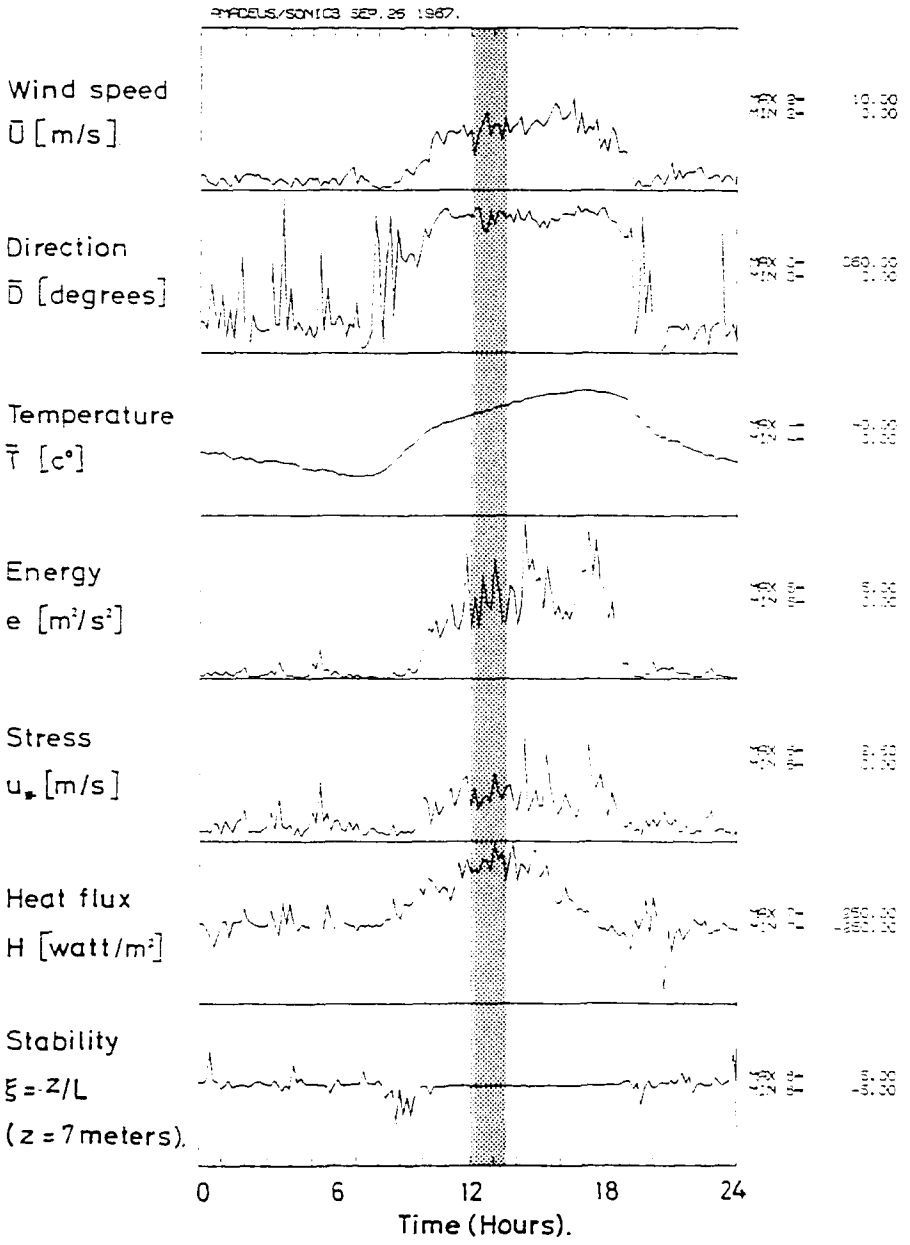

Figure 11: 10-min mean values for Run # 4.

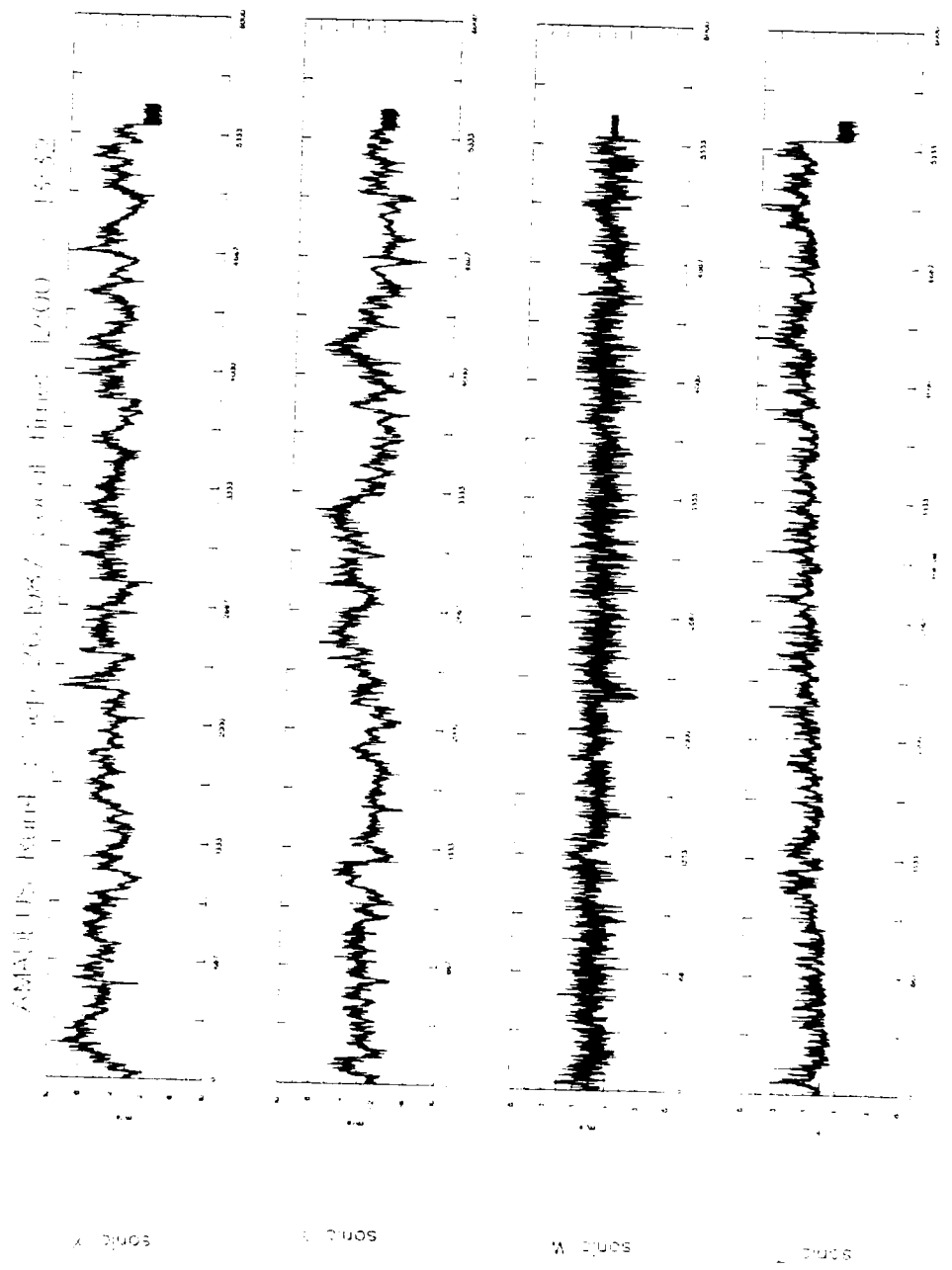

Figure 12: Sonic time series.

Table 4. Mean statistics for time series

	Statistics from 55000 samples							
Mean	u :	3.311	v :	−0.000	w :	−0.000		
Covariance	uu	2.72907	uv :	0.54616	uw :	−0.28961	uT :	−0.01609
			vv :	3.51929	vw :	0.13464	vT :	0.33668
					ww :	0.40845	wT :	0.13848
							TT :	0.81484

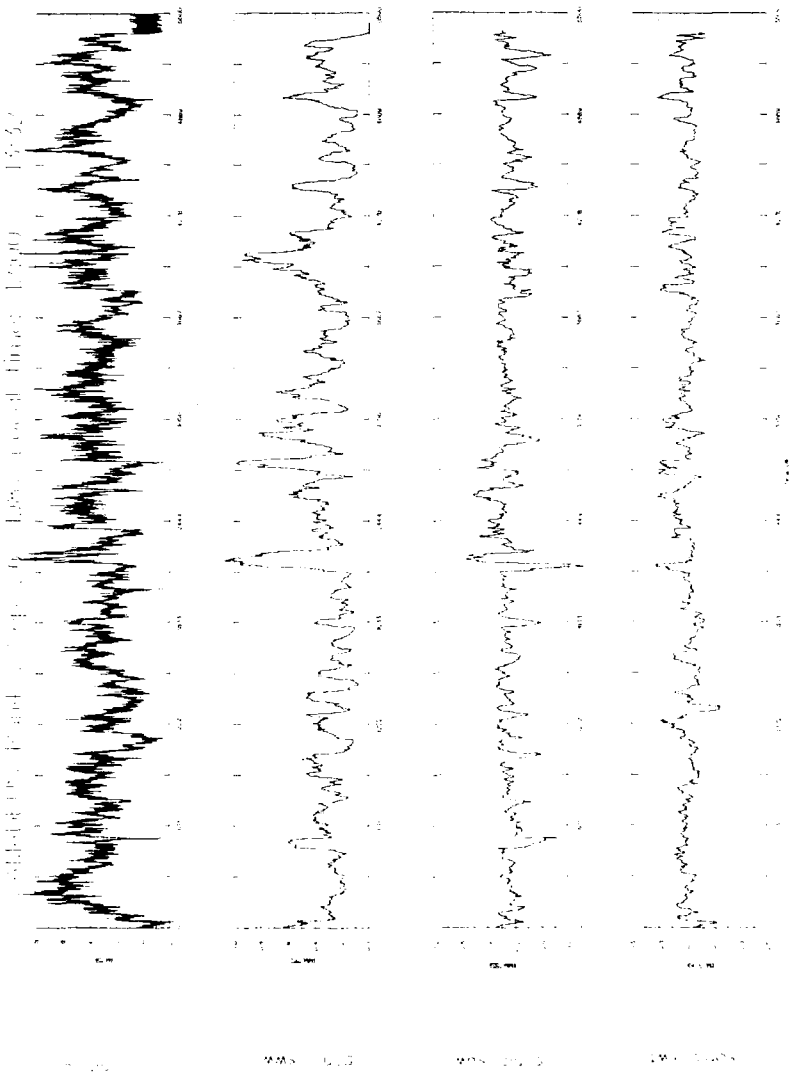

Figure 13: Wind speed (u) and 1-min running mean statistics of vertical variance (uuw), shear stress (uw), and (sensible) heat flux (wt)

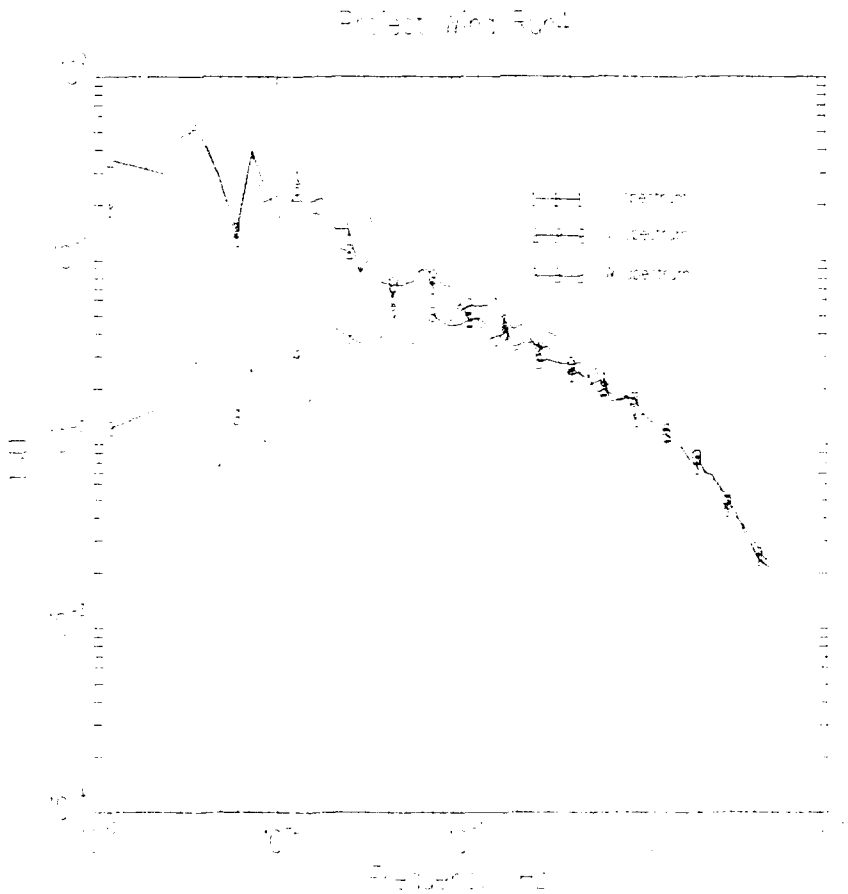

Figure 14: u, v and w-spectra for Run # 4.

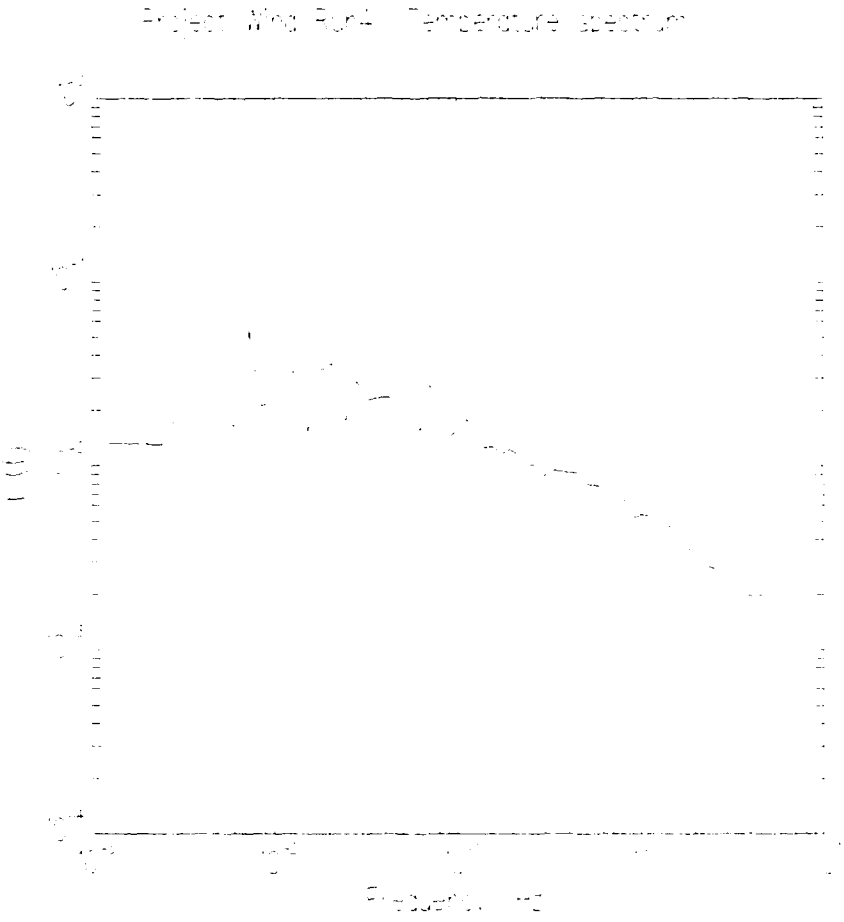

Figure 15. Temperature spectrum for Run # 4.

4.5 Run # 5, 27 September, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1 ch 2 ch 3 ch 5							
(u) (v) (w) (T)							
10 m/s 10 m/s 2 m/s 5°C /Volt							
FM - tape		Date		Start	Stop	Duration	Spectra
# 5		27 Sep		06:15	12:15	6 hrs 00 min	06:15 - 07:47

Run # 5

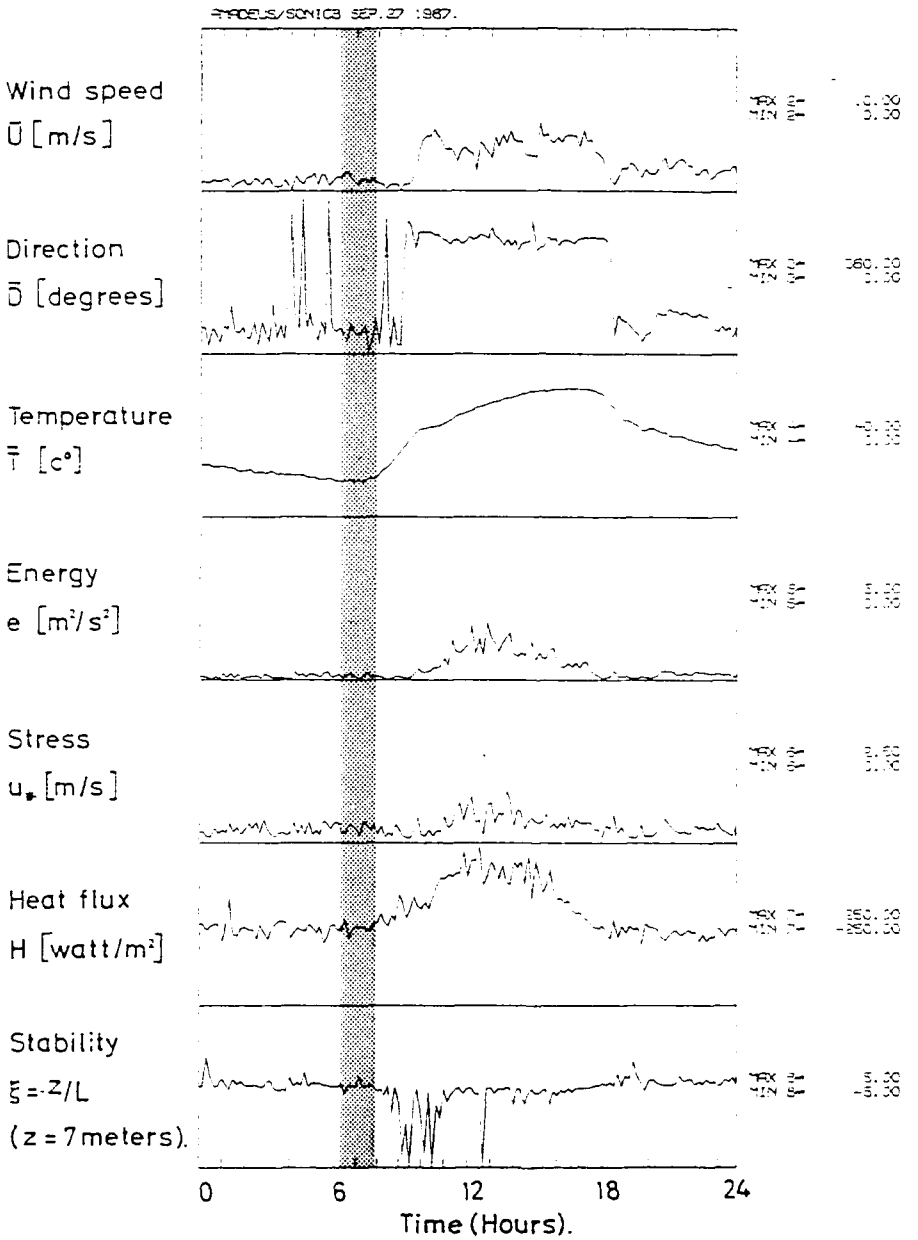

Figure 16: 10-min values for Run # 5.

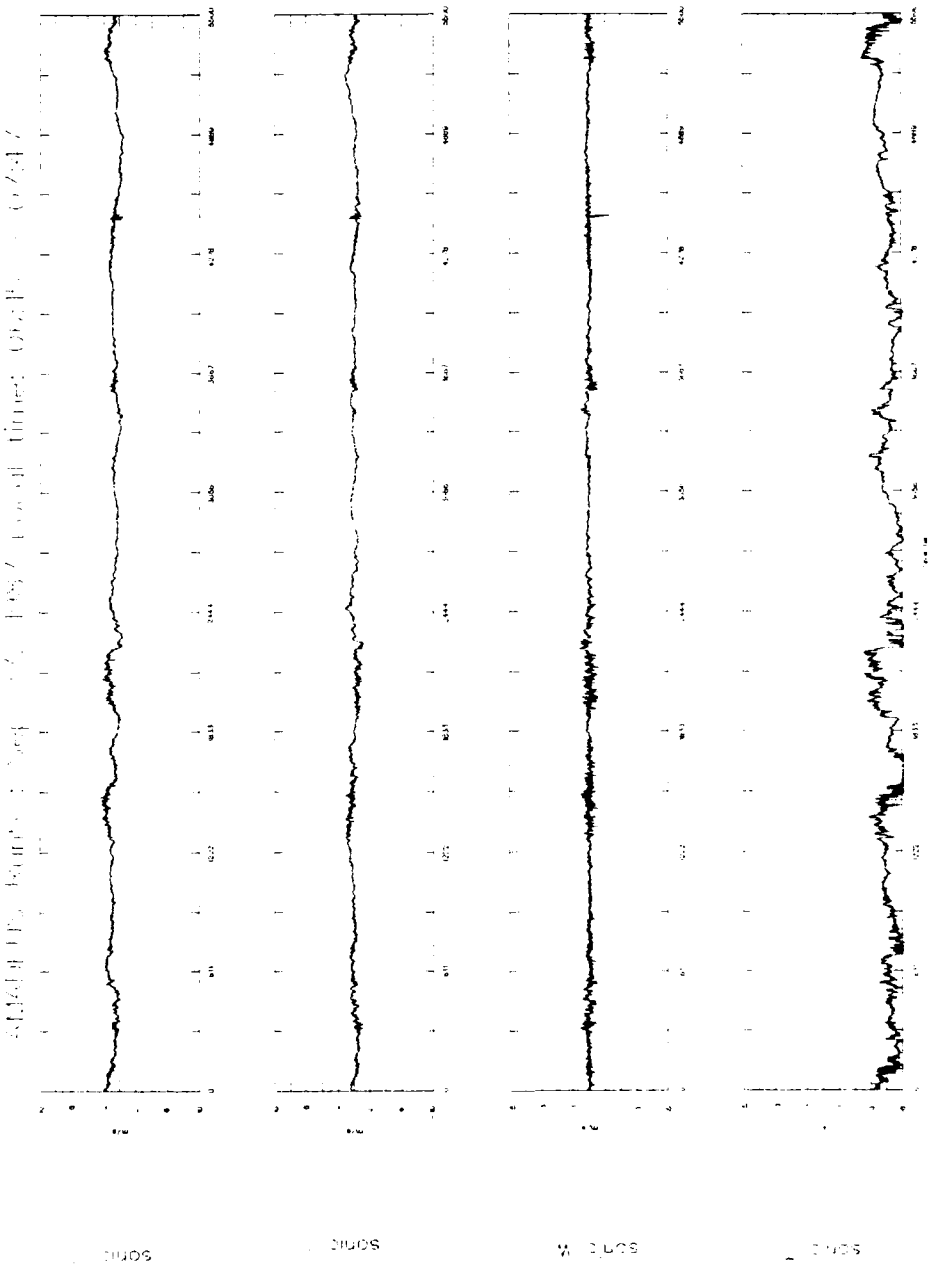

Figure 17: Sonic time series.

Table 5. Mean statistics for time series

	Statistics from 55200 samples							
Mean	u :	0.741	v :	−0.000	w :	−0.000		
Covariance	uu	0.23412	uv :	0.04258	uw :	−0.02463	uT :	0.06632
			vv :	0.12830	vw :	−0.00360	vT :	0.02313
					ww :	0.01479	wT :	−0.00525
							TT :	0.29099

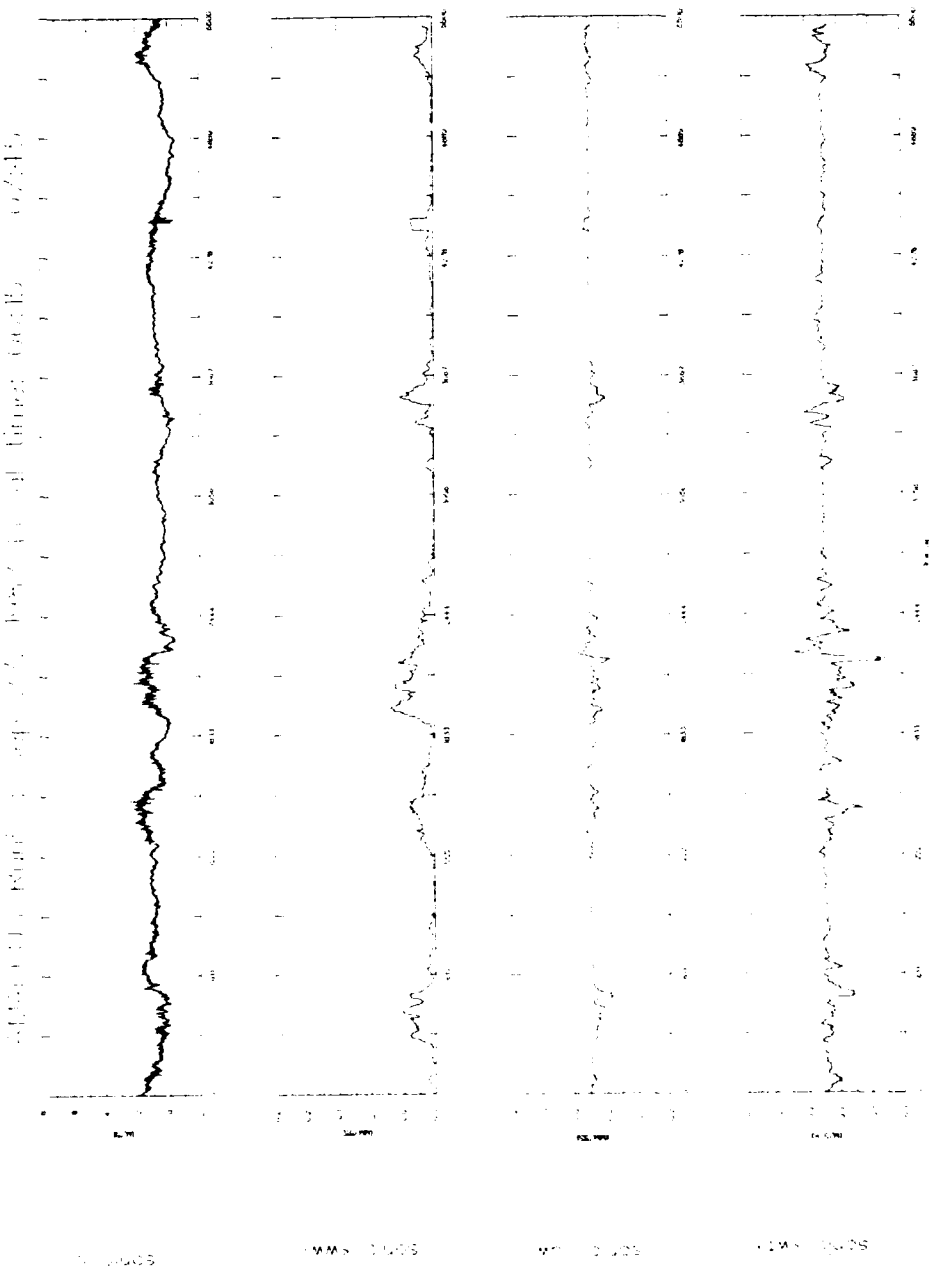

Figure 18. Wind speed (u) and 1-min running mean statistics of vertical variance (ww), shear stress (uw), and (sensible) heat flux (wt).

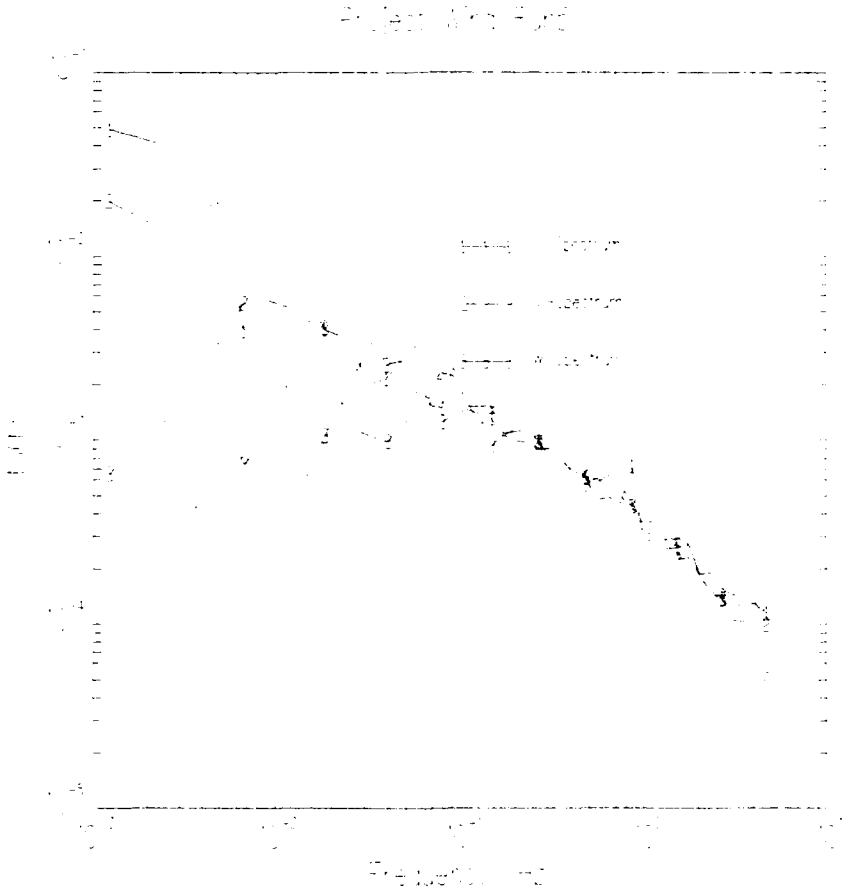

Figure 19: u, v and w-spectra for Run # 5.

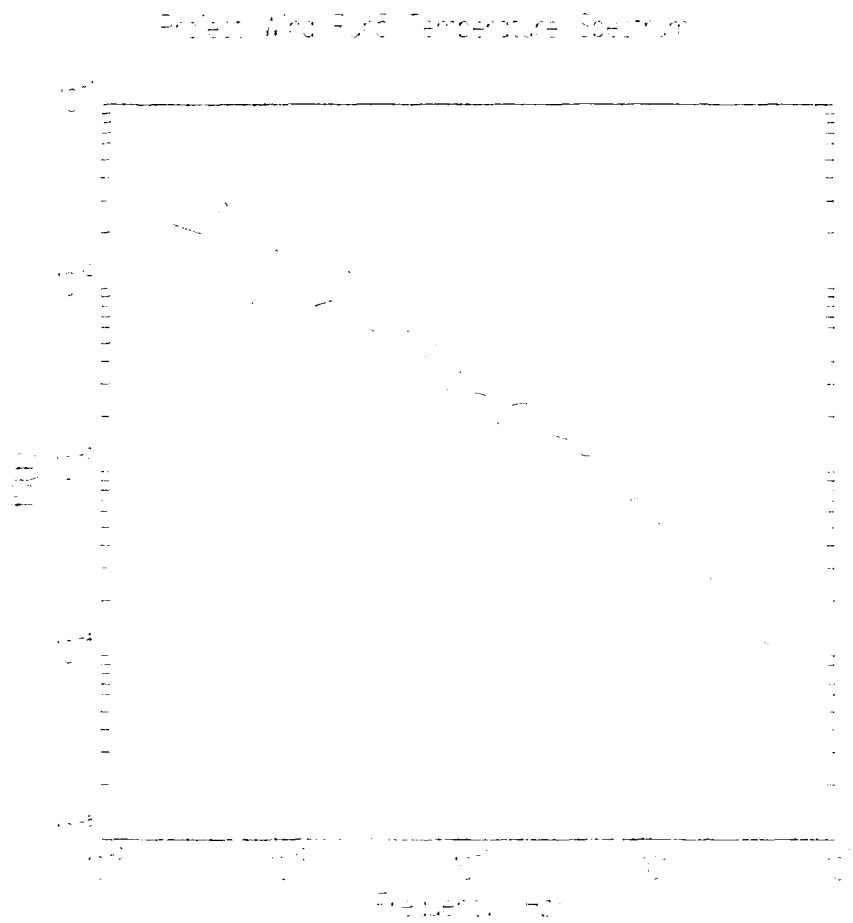

Figure 20: Temperature spectrum for Run # 5.

4.6 Run # 6, 28 September, Overview

Speed: 2.38 cm/s ch 1 (u) 10 m/s	ch 2 (v) 10 m/s	(15/16) ch 3 (w) 2 m/s	(max 8 hrs) ch 5 (T) 5°C /Volt	AMADEUS 1987 Sonic Spectra			
FM - tape		Date		Start	Stop	Duration	Spectra
# 6		28 Sep		10:20	14:52	4 hrs 32 min	10:20 - 11:52

Run # 6

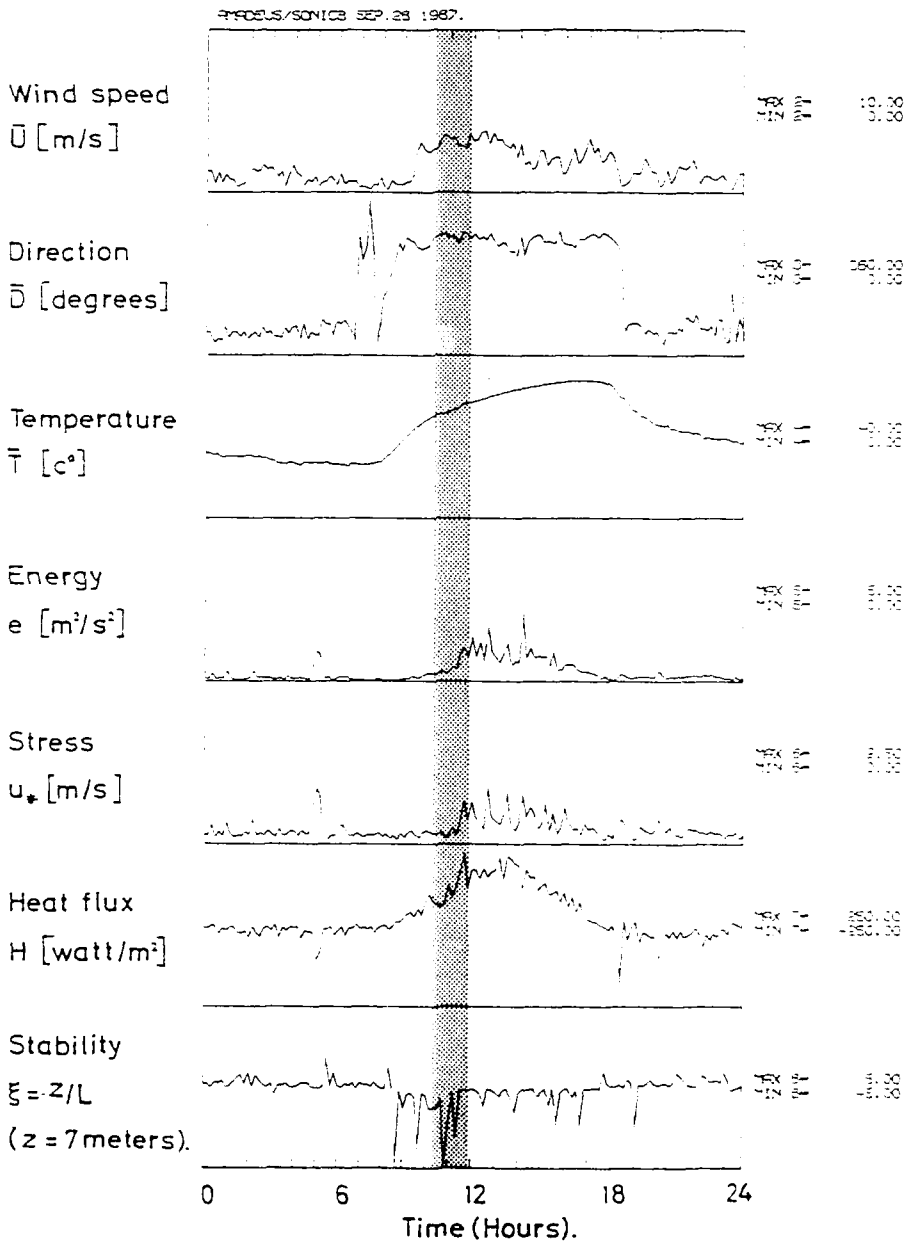

Figure 21: 10-min mean values for Run # 6.

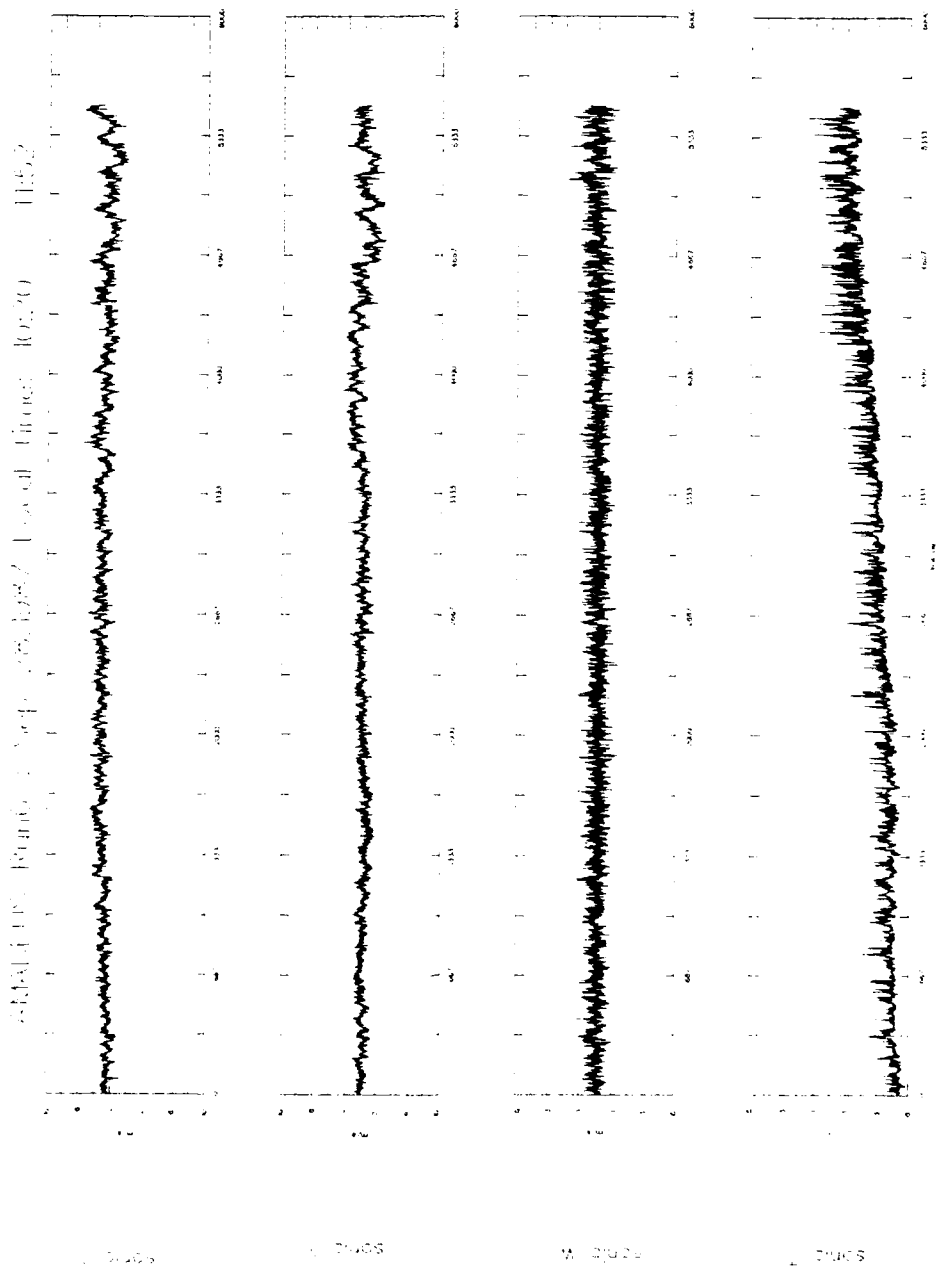

Figure 22: Sonic time series.

Table 6. Mean statistics for time series

	Statistics from 55200 samples							
Mean	u :	0.741	v :	-0.000	w :	-0.000		
Covariance	uu	0.23412	uv :	0.04258	uw :	-0.02463	uT :	0.06632
			vv :	0.12830	vw :	-0.00360	vT :	0.02313
					ww :	0.01479	wT :	-0.00525
							TT :	0.29099

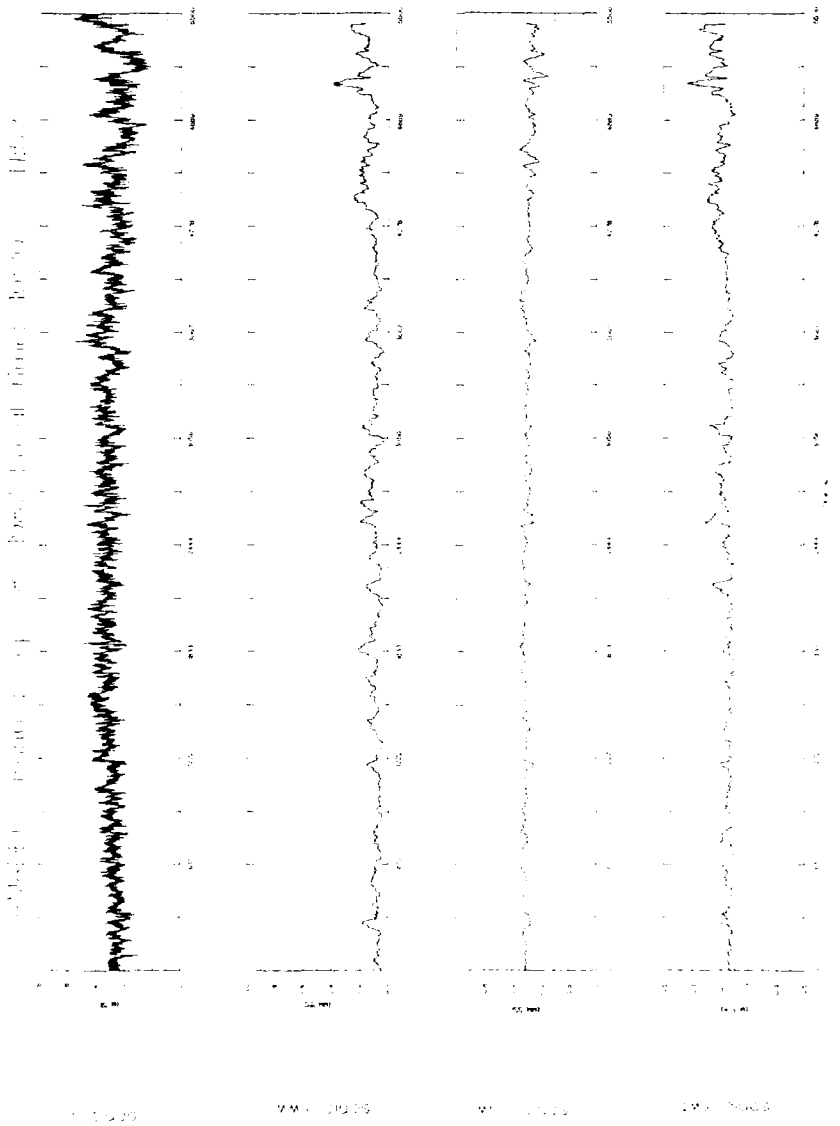

Figure 23. Wind speed (u) and 1-min running mean statistics of vertical variance ($\overline{ww}$), shear stress ($\overline{uw}$), and (sensible) heat flux ($\overline{wt}$).

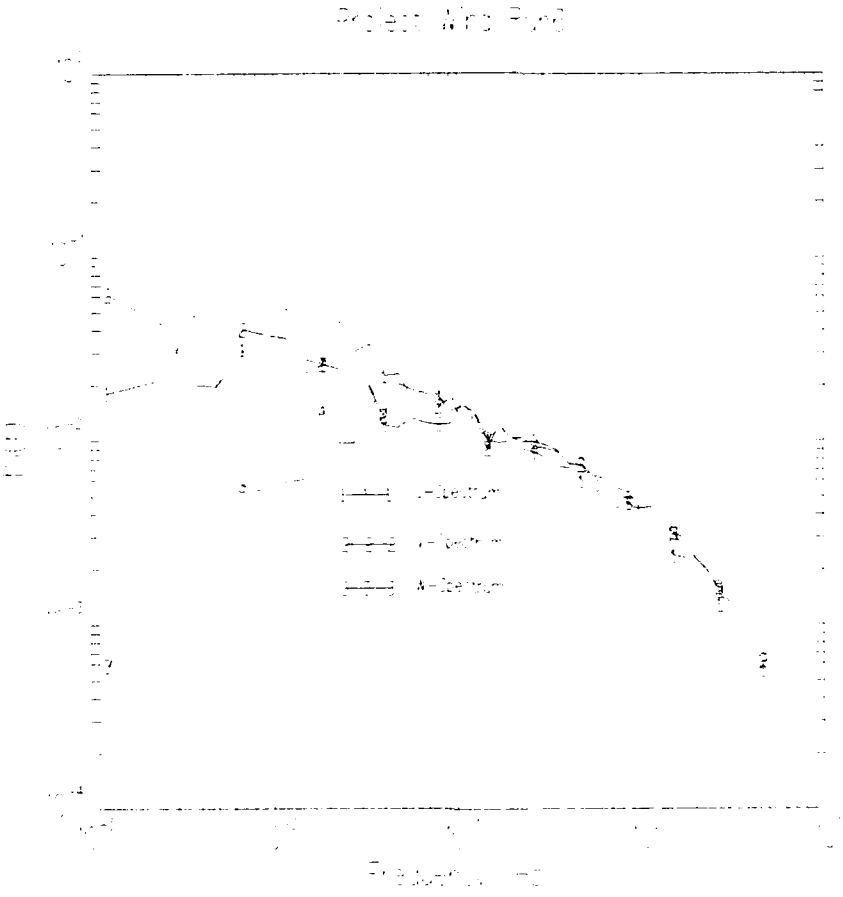

Figure 24. u, v and w-spectra for Run # 6

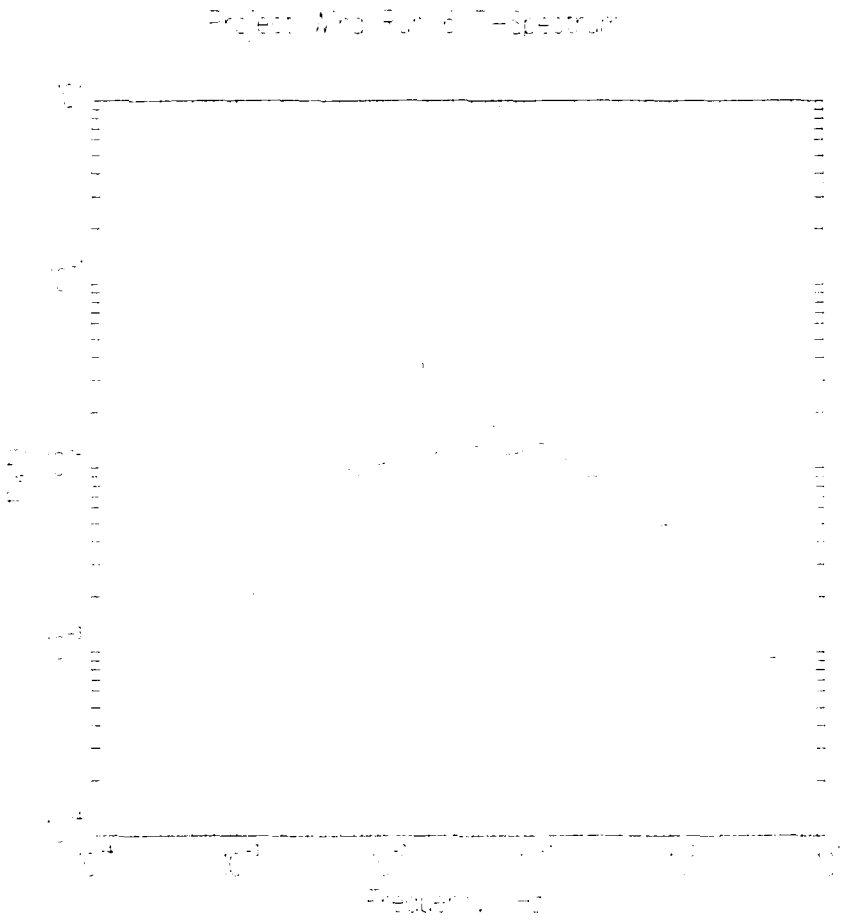

Figure 25: Temperature spectrum for Run # 6.

4.7 Run # 7, 30 September, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1	ch 2	ch 3	ch 5				
(u)	(v)	(w)	(T)				
10 m/s	10 m/s	2 m/s	5°C /Volt				
FM - tape		Date		Start	Stop	Duration	Spectra
# 7		30 Sep		06:22	14:30	8 hrs 08 min	06:32 - 08:04

Run # 7

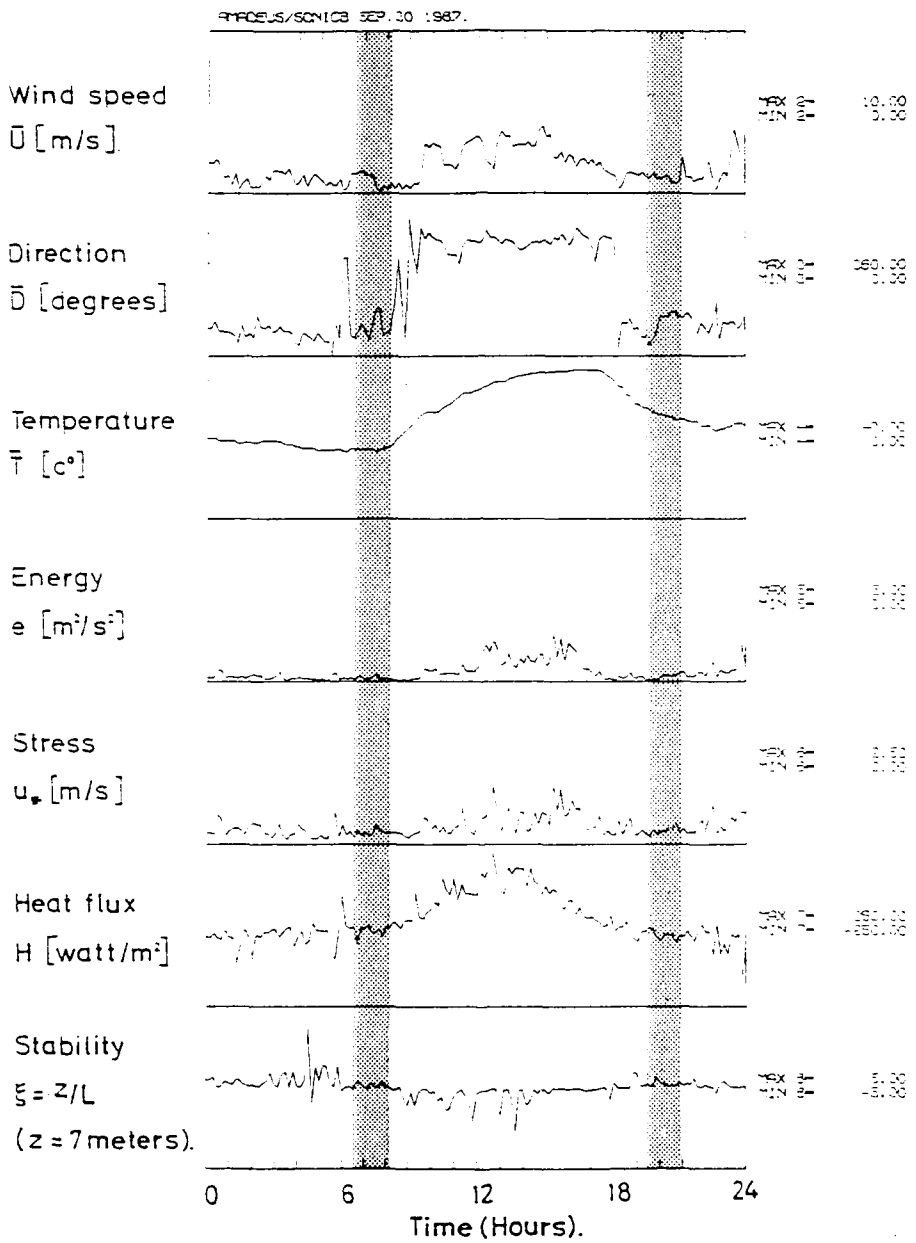

Figure 26: 10-min mean values for Run # 7.

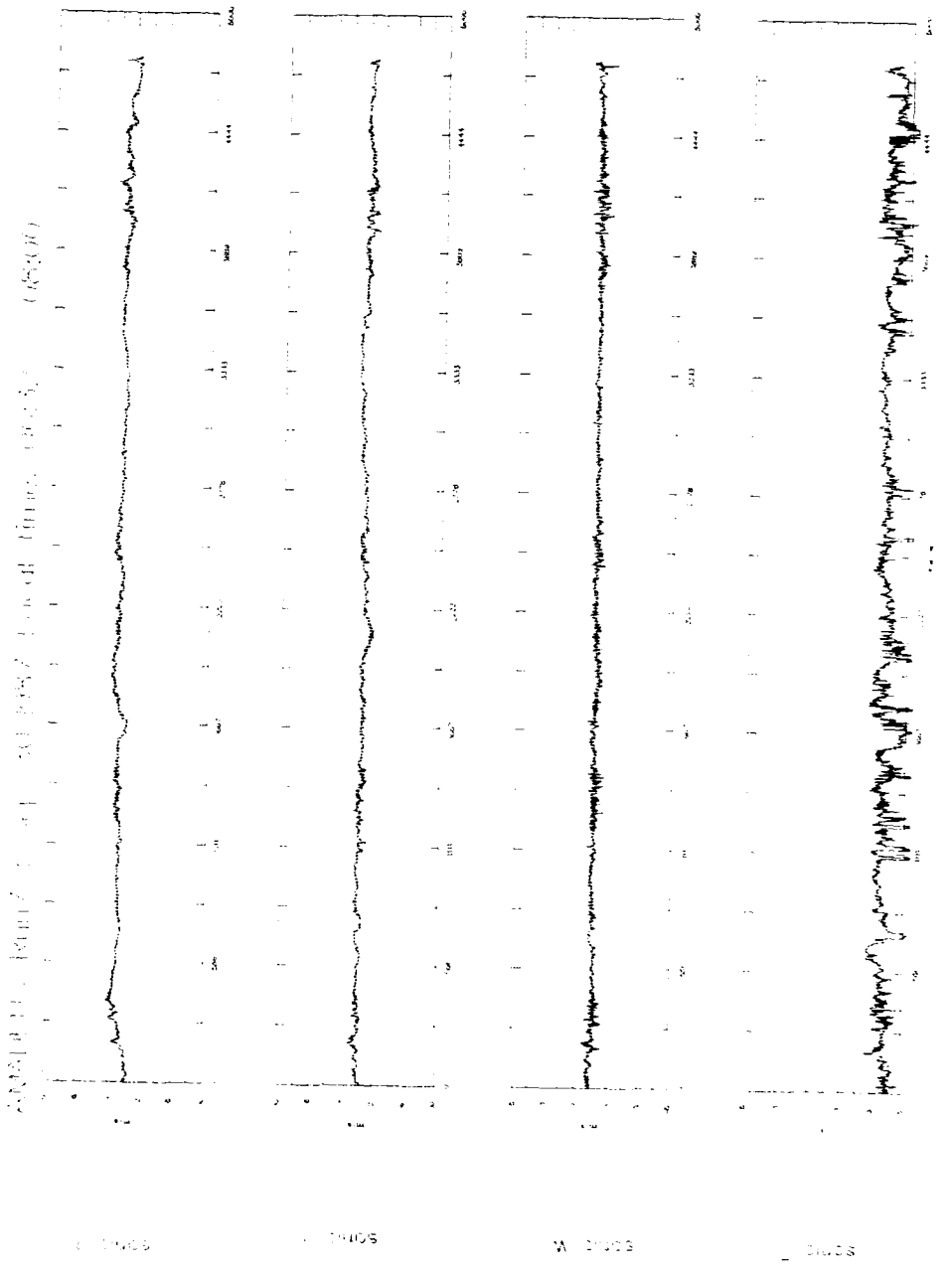

Figure 27: Sonic time series.

Table 7. Mean statistics for time series

	Statistics from 48000 samples							
Mean	u :	1.002	v :	-0.000	w :	0.000		
Covariance	uu	0.23741	uv :	0.00991	uw :	-0.03317	uT :	0.09588
			vv	0.13675	vw :	0.00083	vT :	0.05768
					ww :	0.01936	wT :	-0.01773
							TT :	0.27148

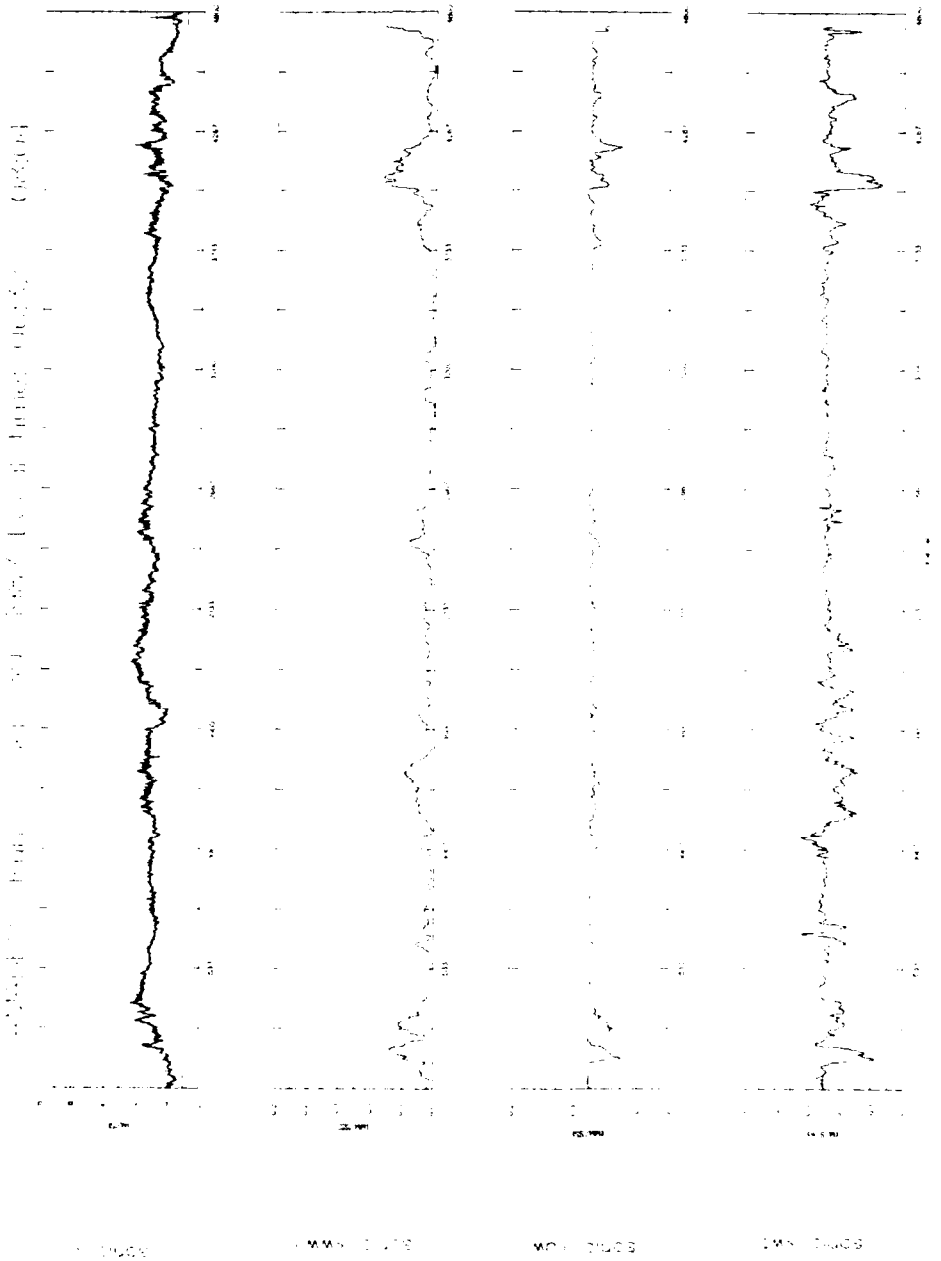

Figure 28. Wind speed (u) and 1-min running mean statistics of vertical variance ($\overline{ww}$), shear stress ($\overline{uw}$), and (sensible) heat flux ($\overline{wt}$).

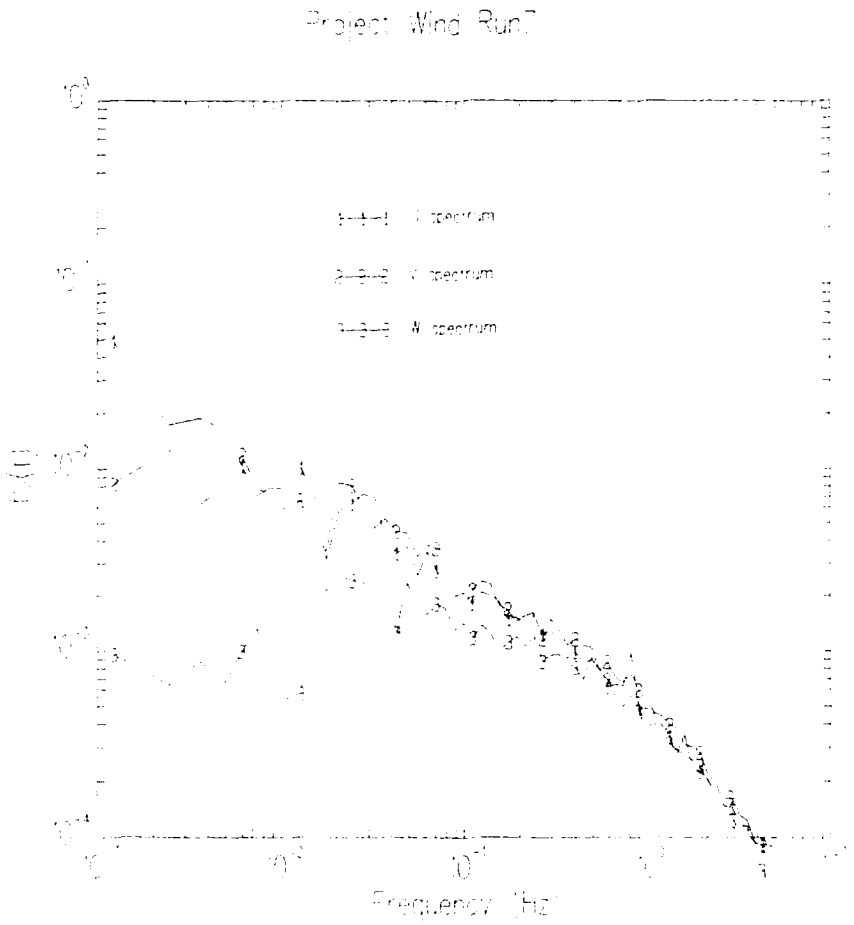

Figure 29. u, v and w-spectra for Run # 7

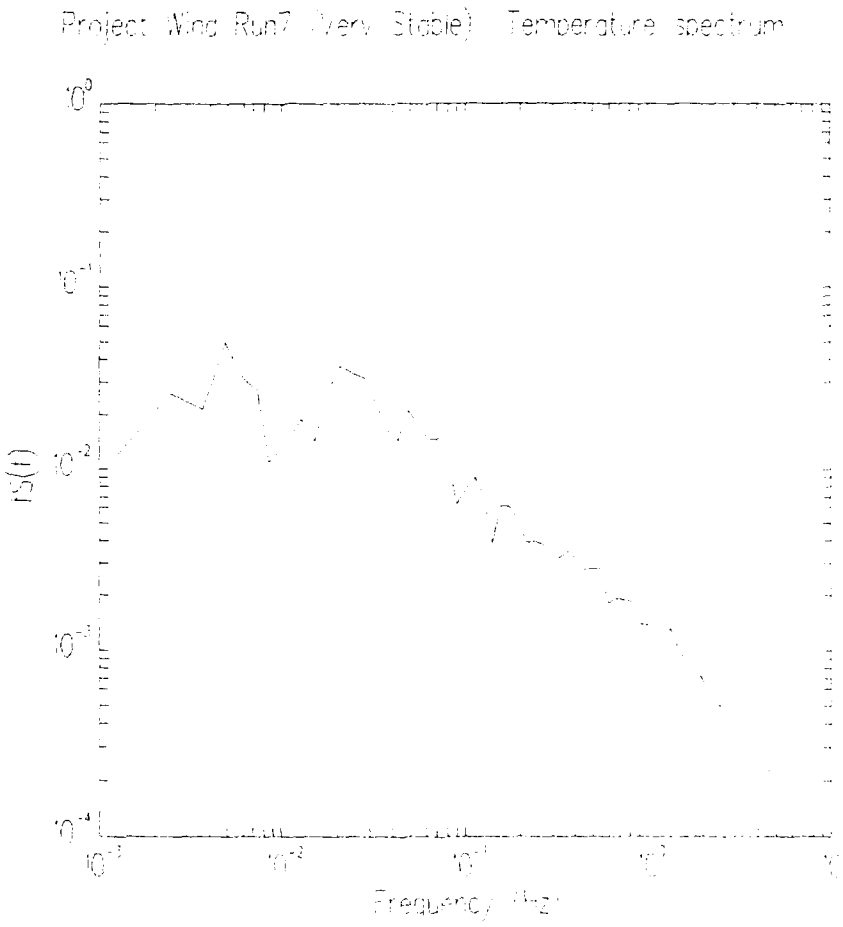

Figure 30: Temperature spectrum for Run # 7.

4.8 Run # 8, 30 September, Overview

Speed: 2.38 cm/s	(15/16)	(max 8 hrs)	AMADEUS 1987 Sonic Spectra			
ch 1	ch 2	ch 3	ch 5			
(u)	(v)	(w)	(T)			
10 m/s	10 m/s	2 m/s	5°C /Volt			
FM – tape	Date		Start	Stop	Duration	Spectra
# 8	30 Sep		17:35	01:43	8 hrs 08 min	19:25 – 20:57

Run # 8

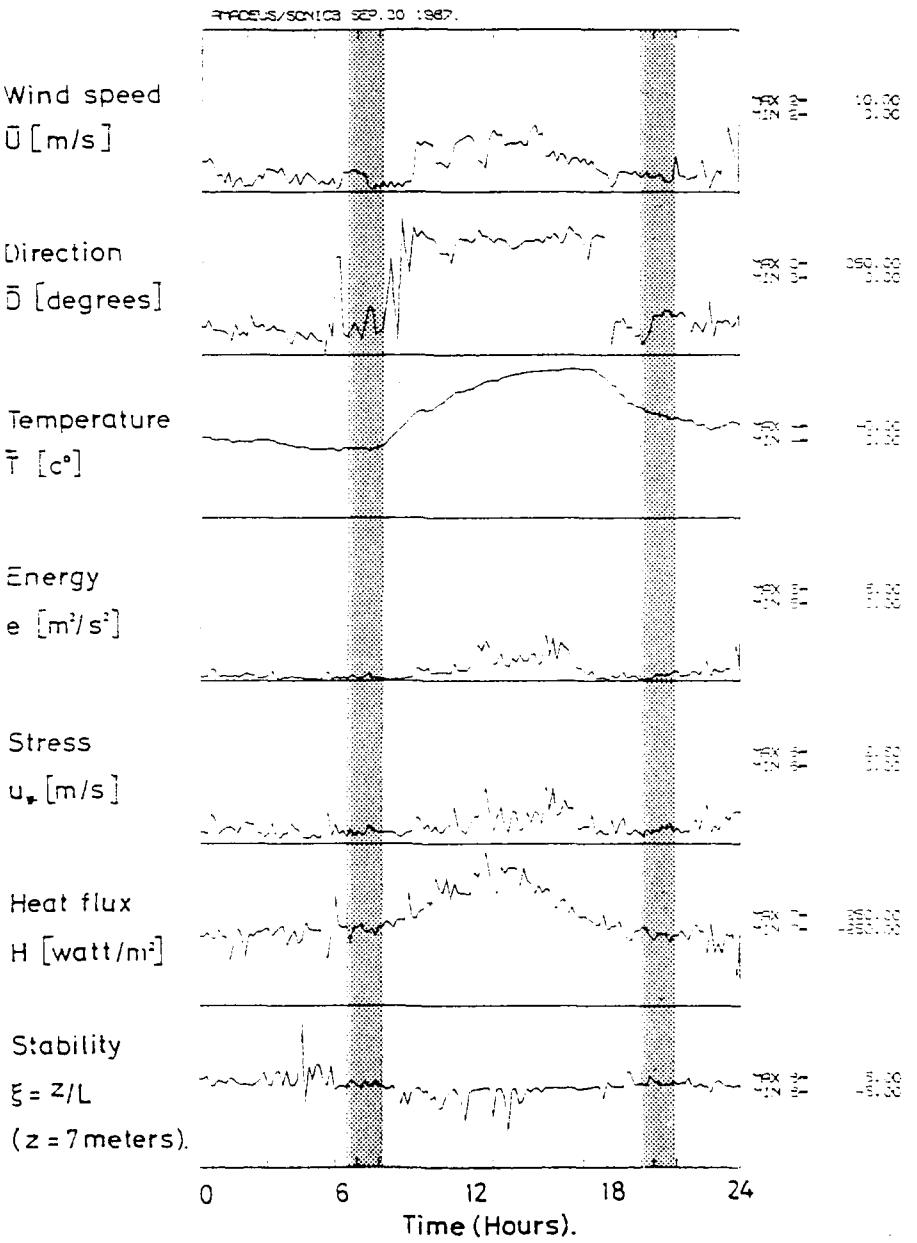

Figure 31: 10-min mean values for Run # 8.

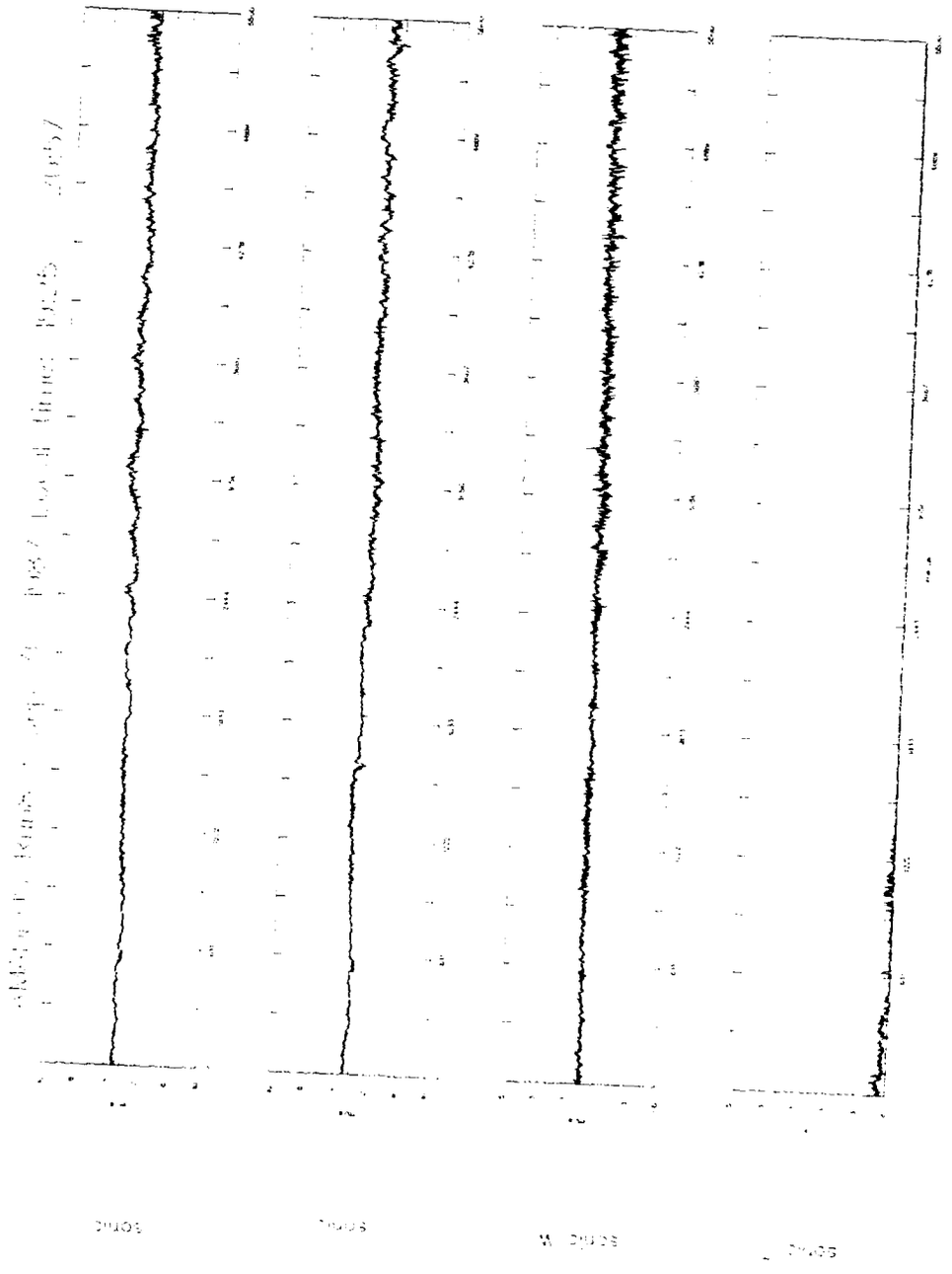

Figure 39: Sonic time series.

Table 8. Mean statistics for time series.

	Statistics from 55200 samples							
Mean	u :	0.747	v :	0.000	w :	-0.000		
Covariance	uu	0.12706	uv :	-0.00191	uw :	-0.02547	uT :	
			vv :	0.26868	vw :	0.00336	vT :	
					ww :	0.02908	wT :	
							TT	

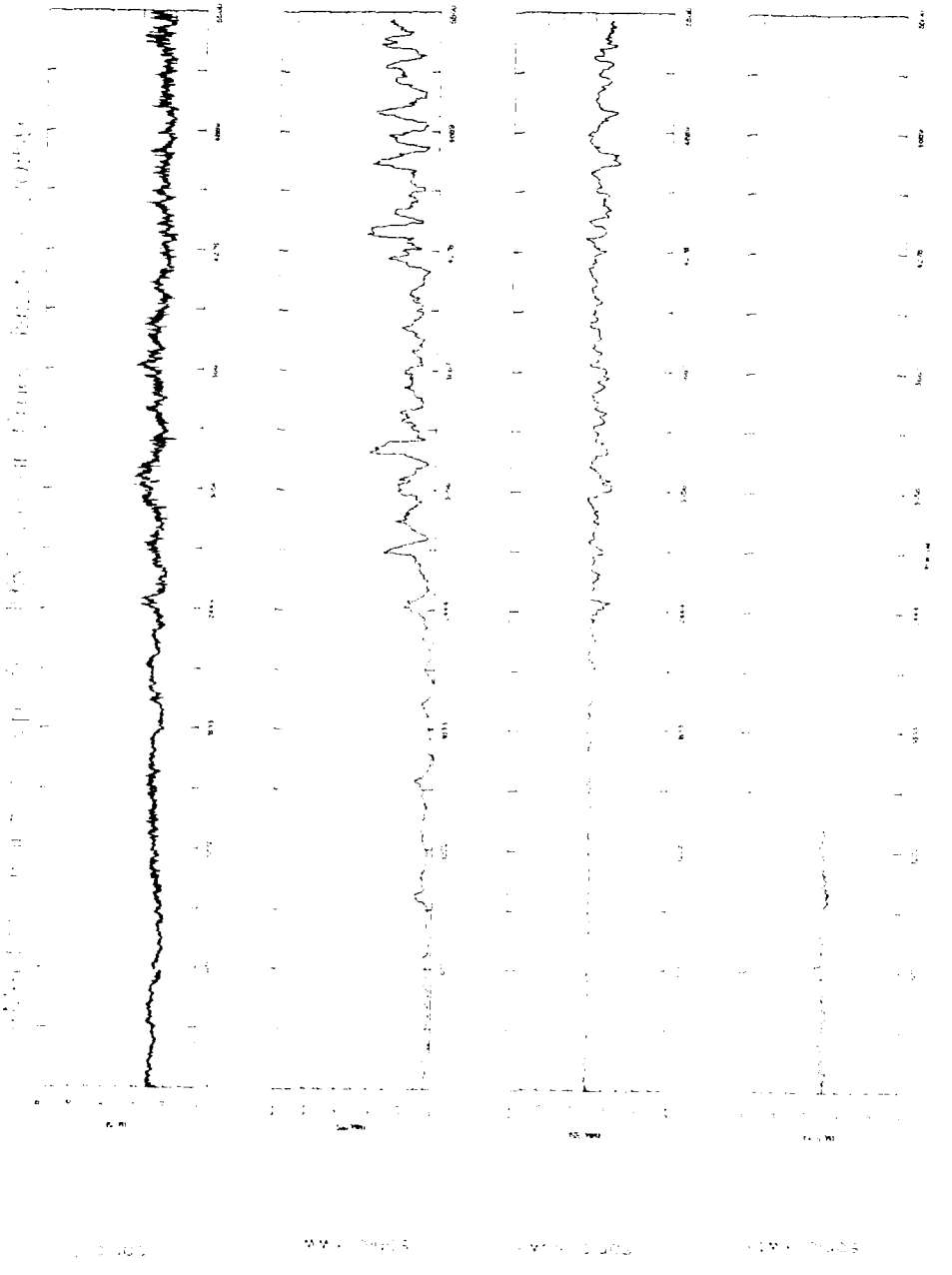

Figure 13. Wind speed (u) and 1-min running mean statistics of vertical variance (ww), shear stress (uw), and (sensible) heat flux (wt)

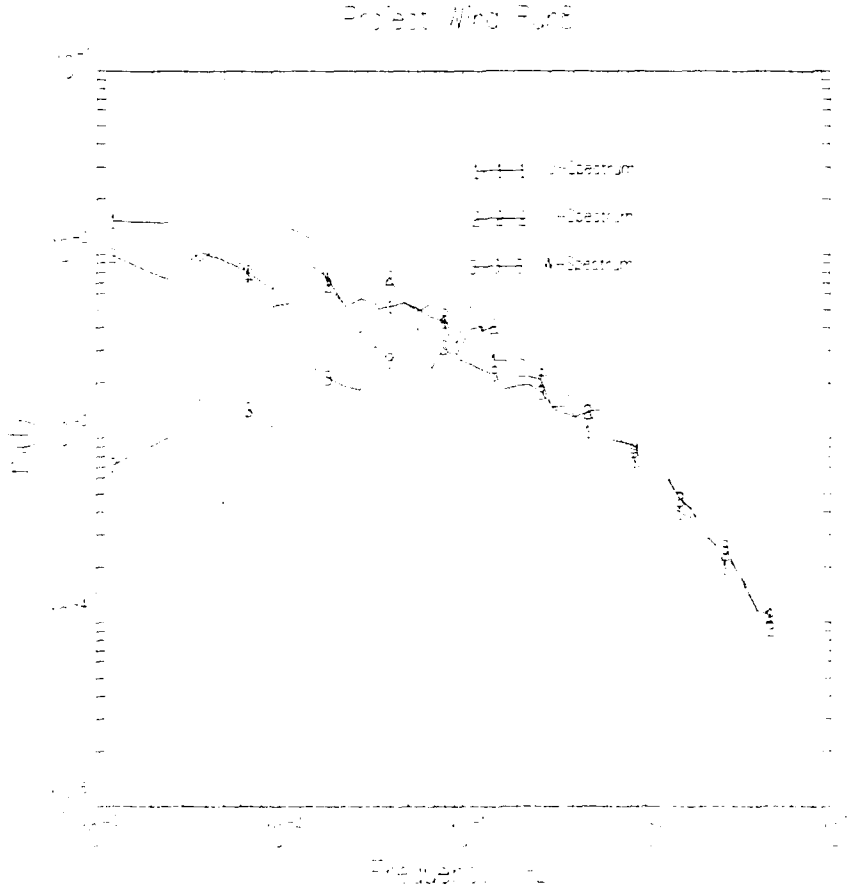

Figure 14: u, v and w-spectra for Run # 8.

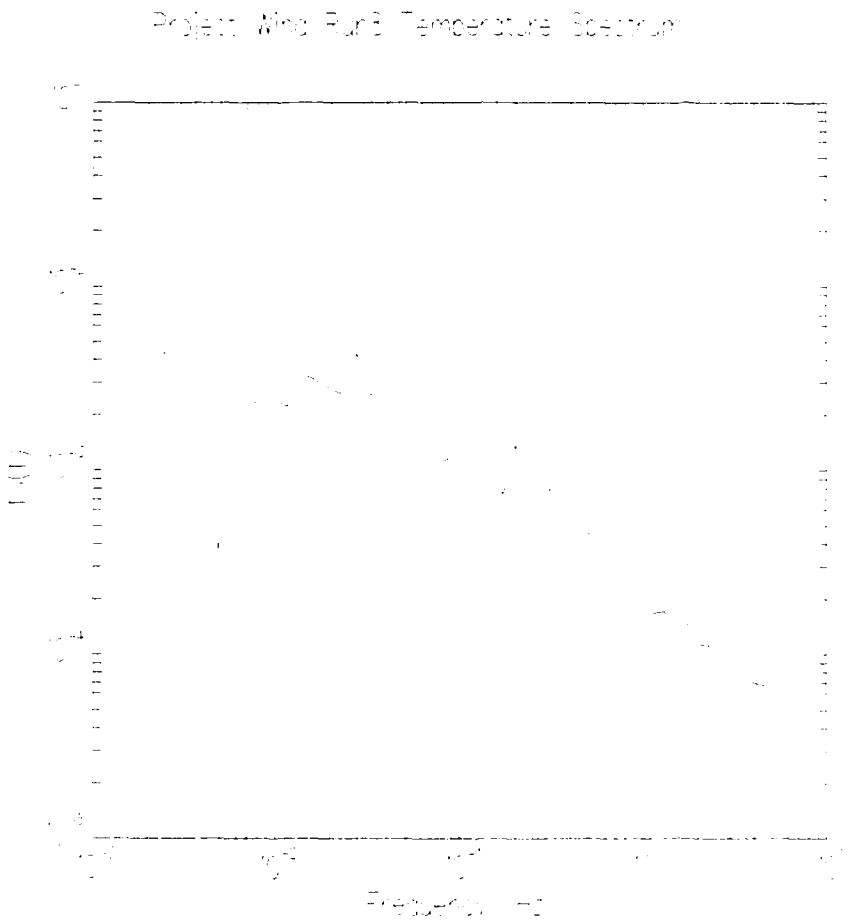

Figure 35: Temperature spectrum for Run # 8

4.9 Run # 9, 1 October, Overview

Speed: 2.38 cm/s		(15/16)	(max 8 hrs)	AMADEUS 1987 Sonic Spectra			
ch 1	ch 2	ch 3	ch 5				
(u)	(v)	(w)	(T)				
10 m/s	10 m/s	2 m/s	5°C /Volt				
FM - tape		Date		Start	Stop	Duration	Spectra
# 9		01 Oct		06:32	14:42	8 hrs 10 min	06:32 - 08:04

Run # 9

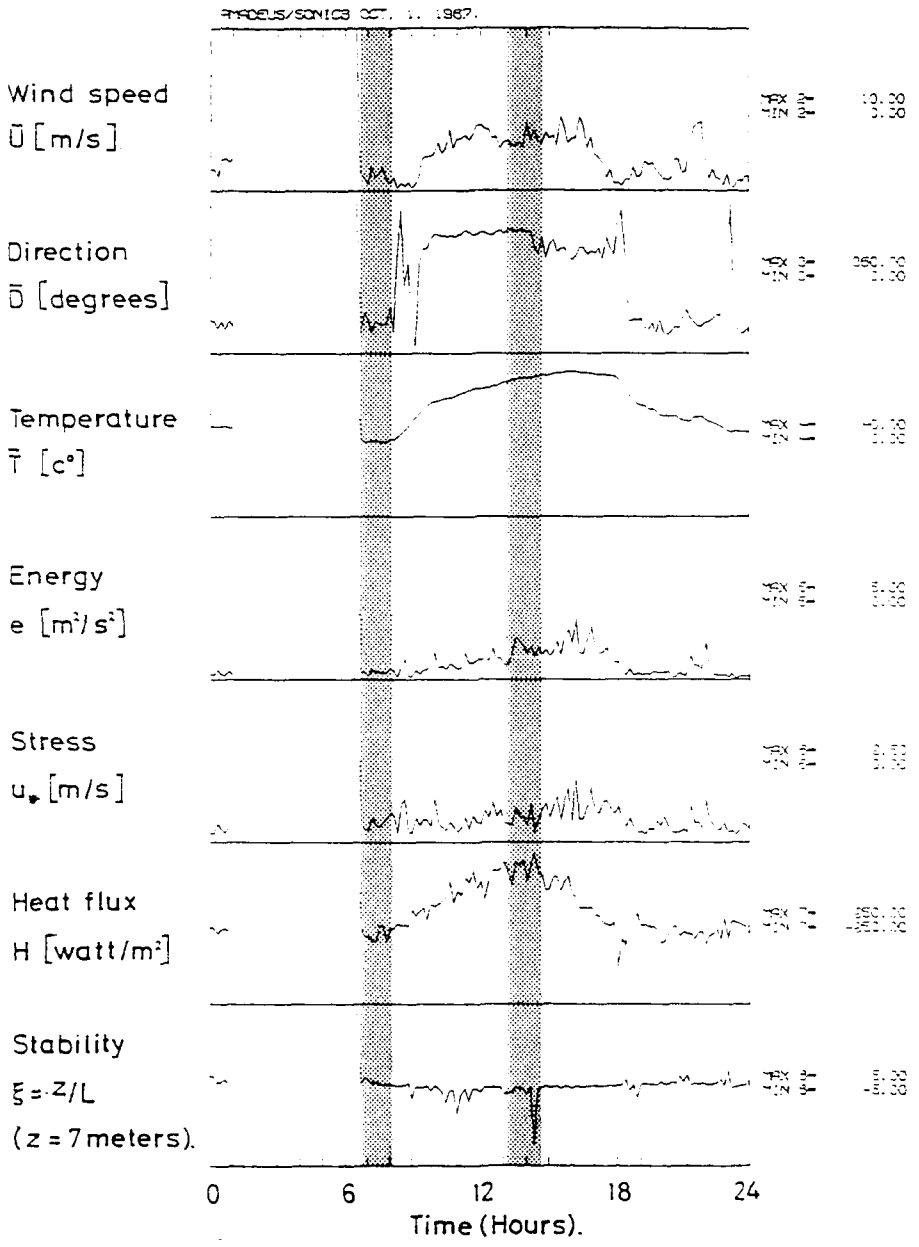

Figure 36: 10-min mean values for Run # 9.

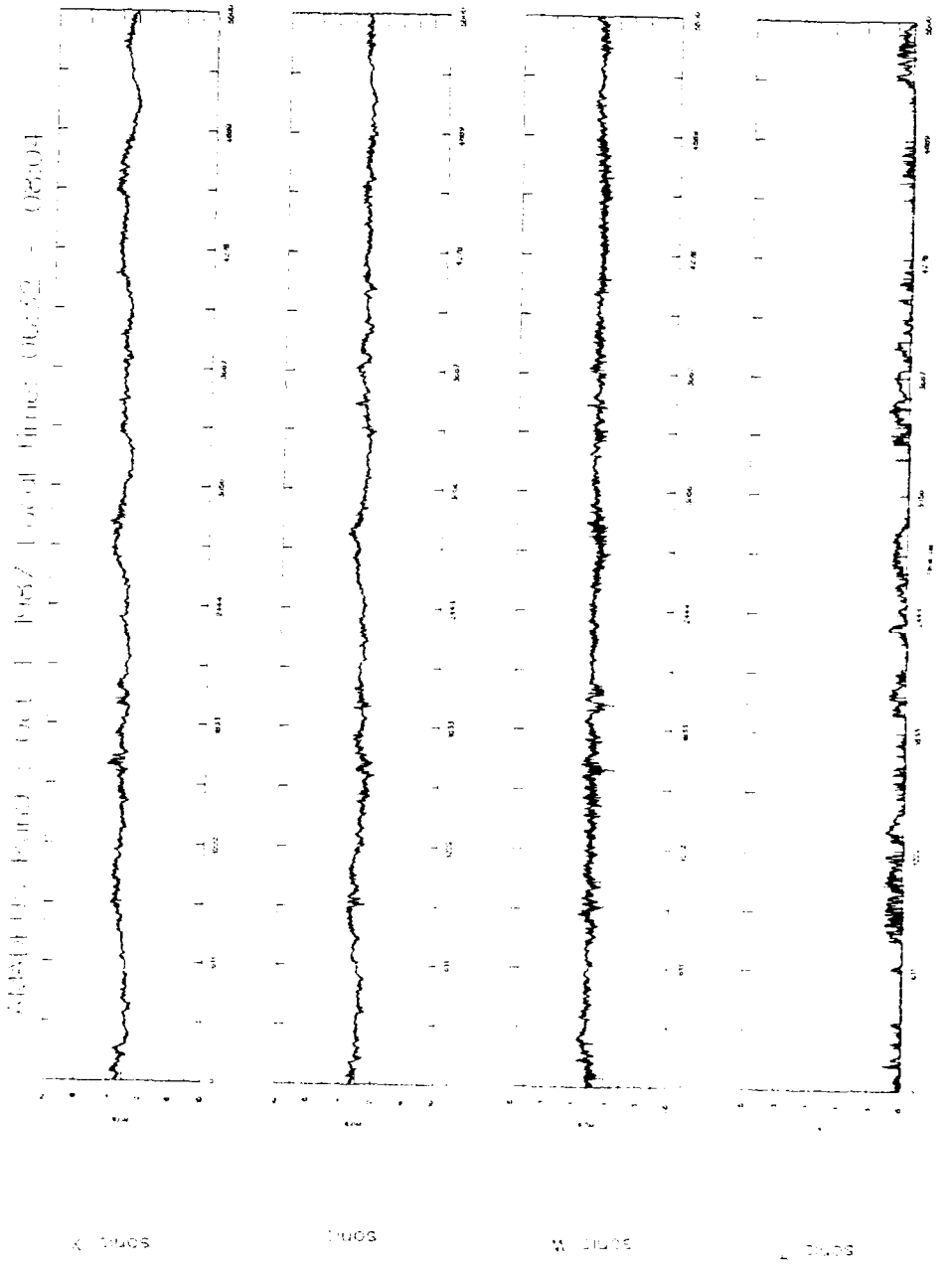

Figure 37: Sonic time series.

Table 9. Mean statistics for time series.

	Statistics from 55200 samples							
Mean	u :	0.753	v :	-0.000	w :	0.000		
Covariance	uu	0.36718	uv :	0.11913	uw :	- 0.07063	uT	0.06647
			vv :	0.20350	vw :	-0.02155	vT :	0.06249
					ww :	0.04225	wT :	-0.01743
							TT :	0.11900

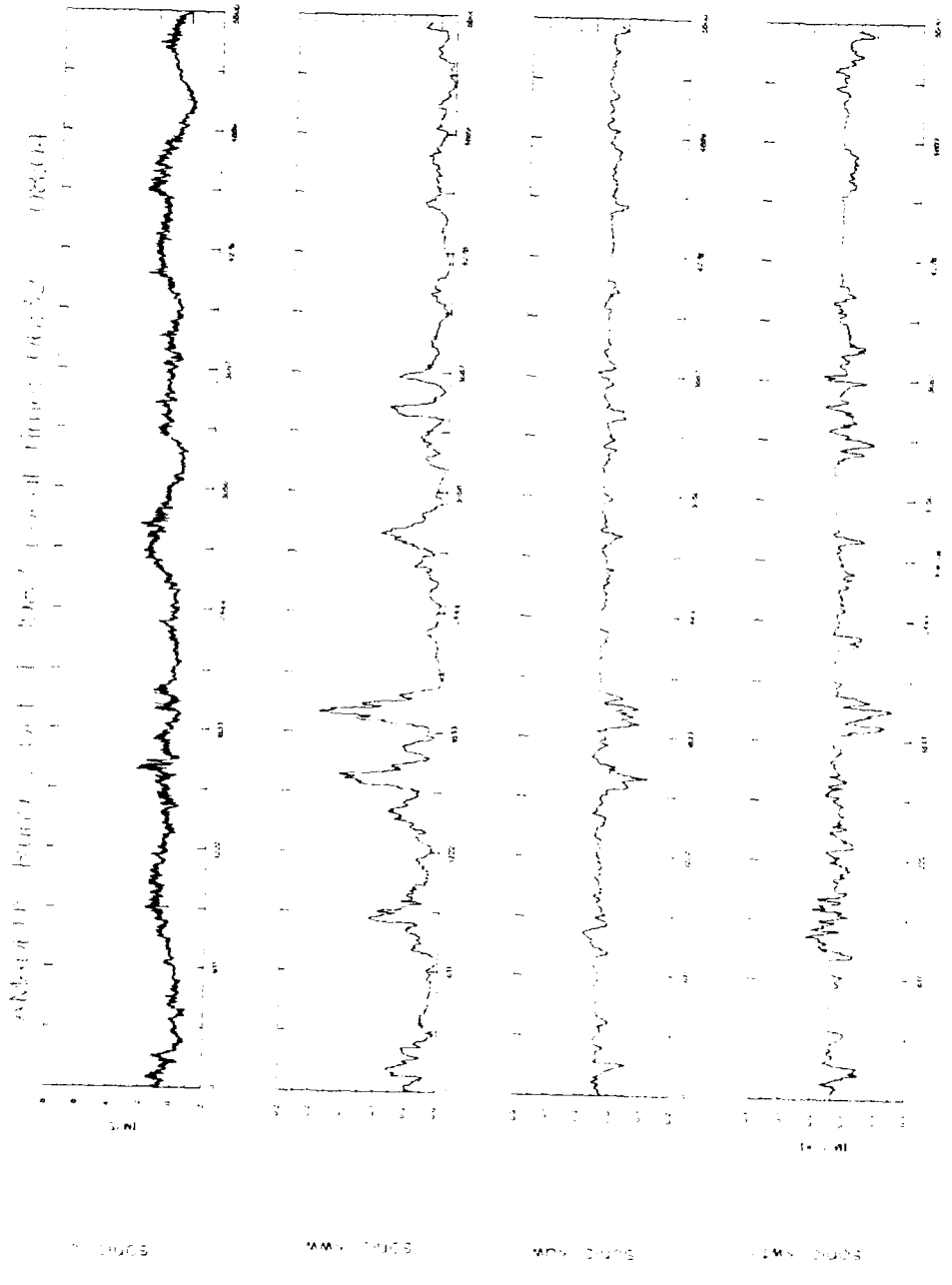

Figure 38: Wind speed (u) and 1-min running mean statistics of vertical variance (ww), shear stress (uw), and (sensible) heat flux (wt).

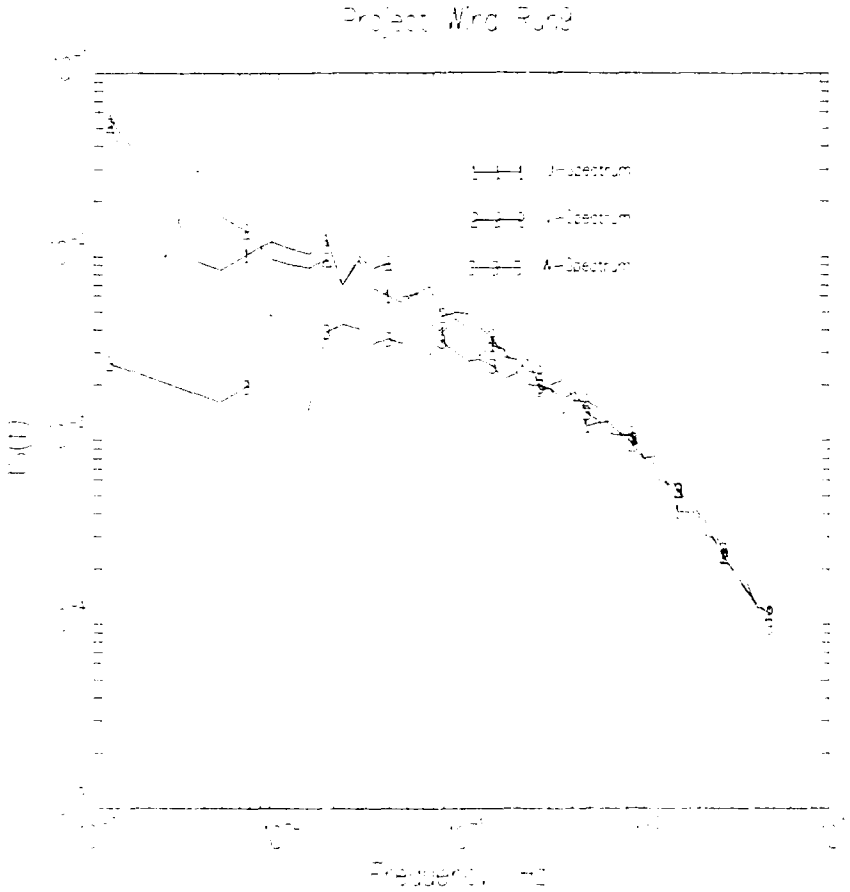

Figure 39: u, v and w-spectra for Run # 9.

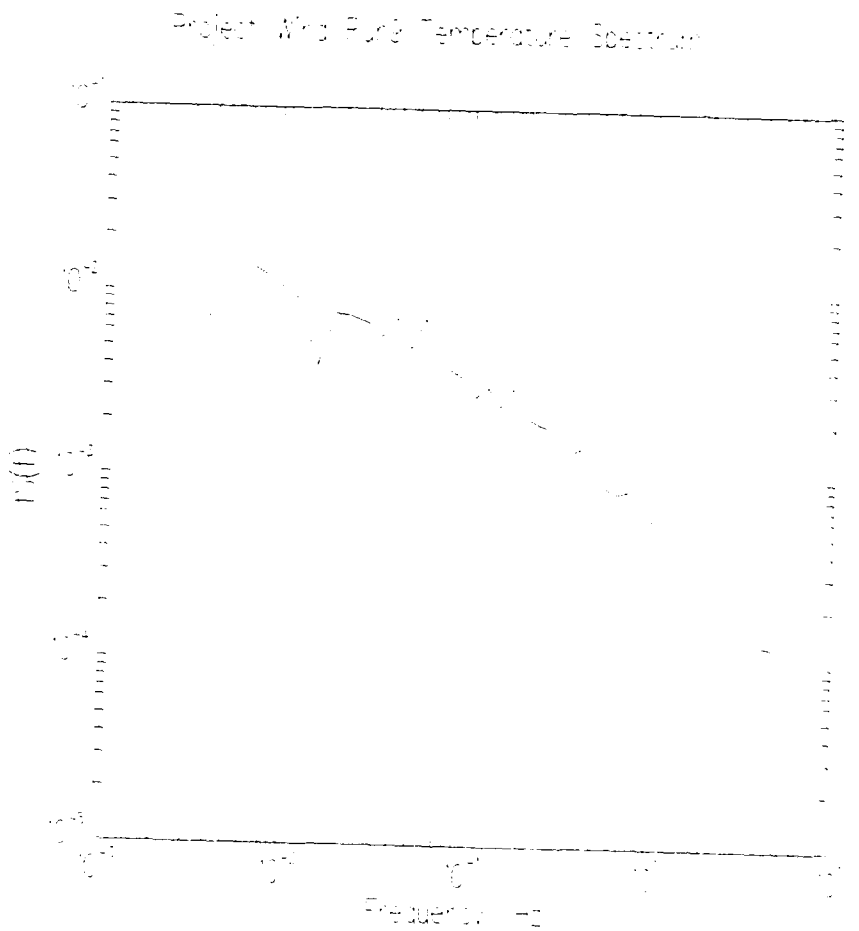

Figure 40: Temperature spectrum for Run # 9.

4.10 Run # 10, 01 October, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1	ch 2	ch 3	ch 5				
(u)	(v)	(w)	(T)				
10 m/s	10 m/s	2 m/s	5°C /Volt				
FM - tape		Date		Start	Stop	Duration	Spectra
# 10		01 Oct		06:32	14:42	8 hrs 10 min	13:10 - 14:42

Run # 10

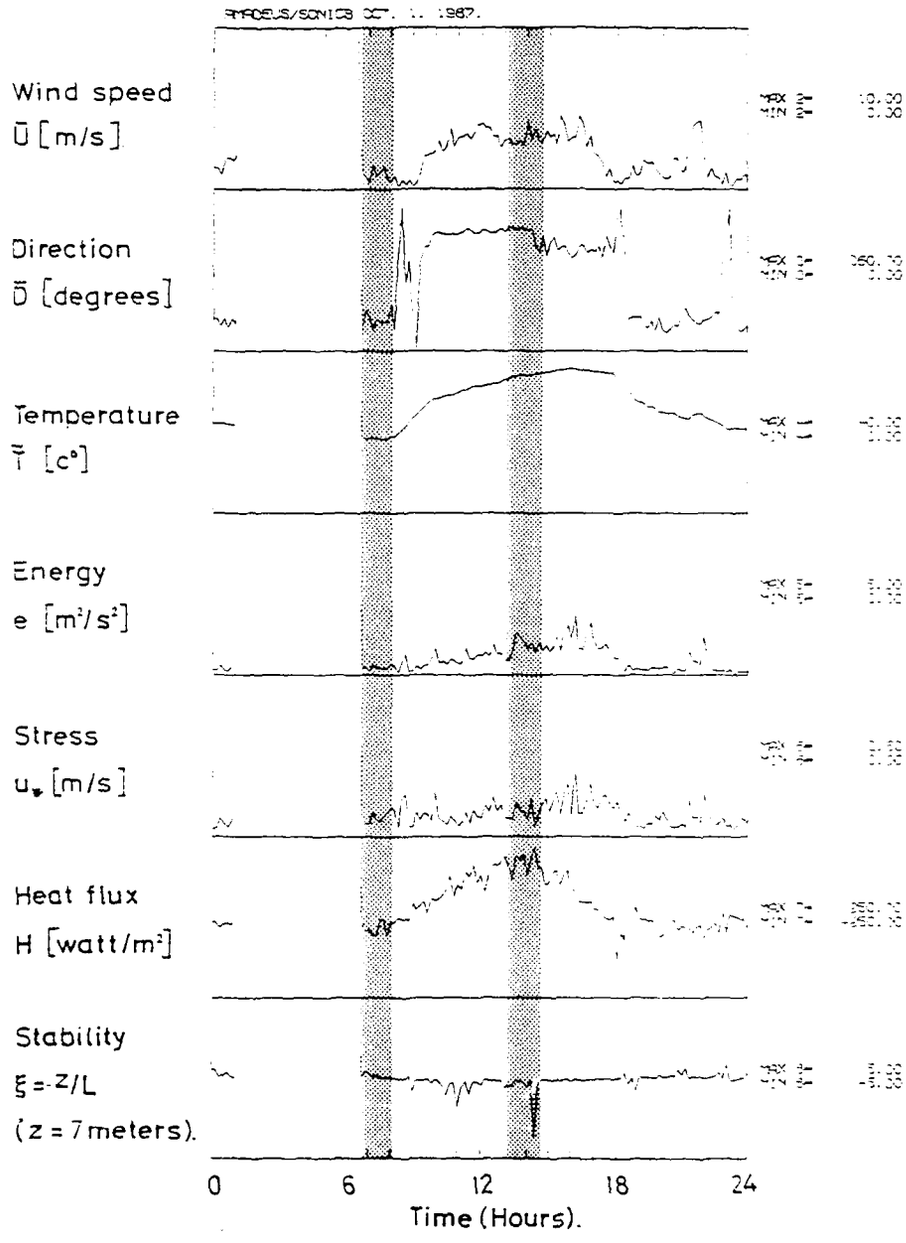

Figure 41: 10-min mean values for Run # 10.

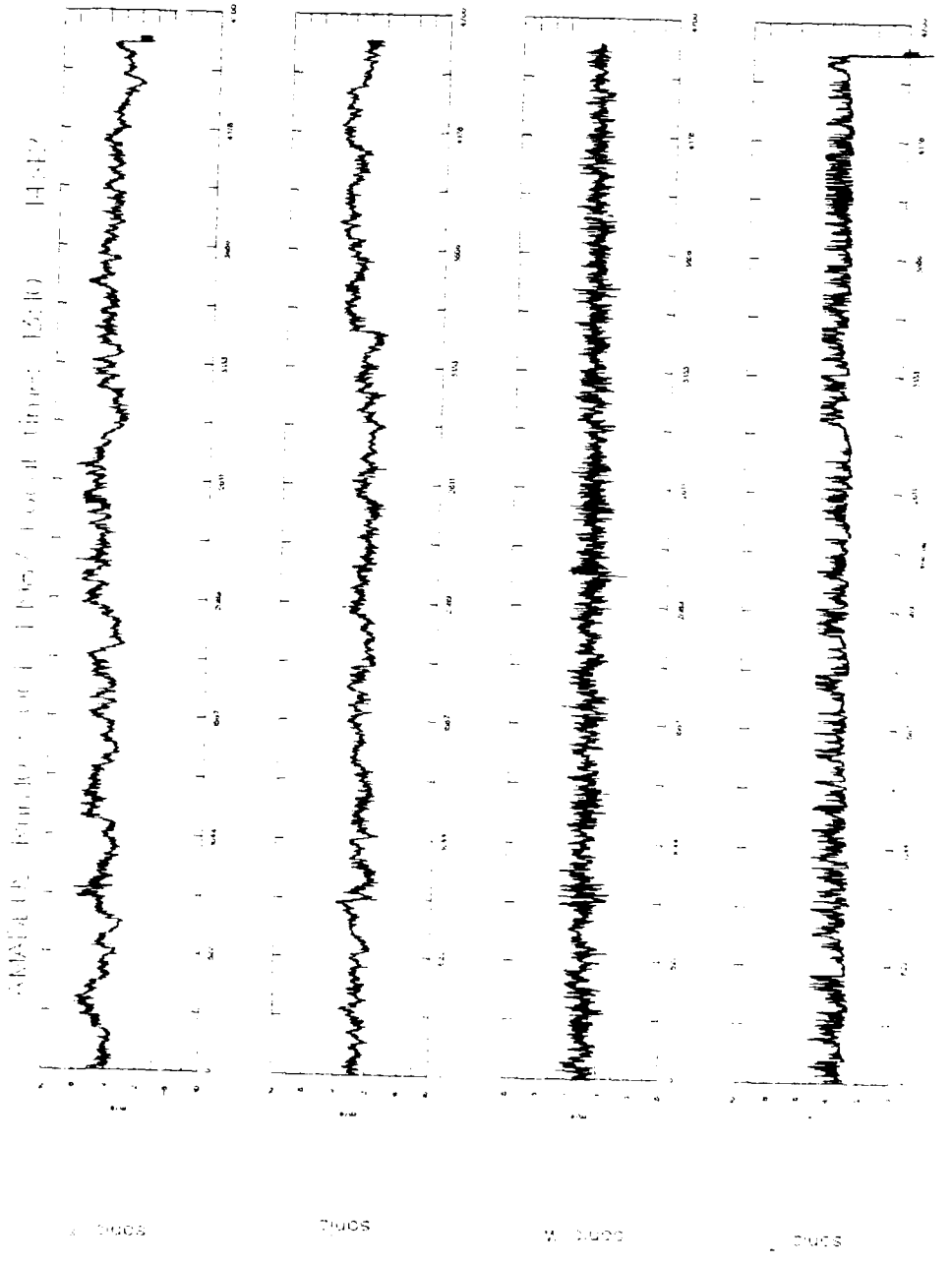

Figure 42: Sonic time series.

Table 10. Mean statistics for time series.

	Statistics from 55000 samples							
Mean	u :	2.476	v :	0.000	w :	-0.000		
Covariance	uu	2.36271	uv :	-0.09837	uw :	-0.05444	uT :	1.57620
			vv :	1.34777	vw :	0.03667	vT :	0.12990
					ww :	0.15209	wT :	0.09843
							TT :	2.33105

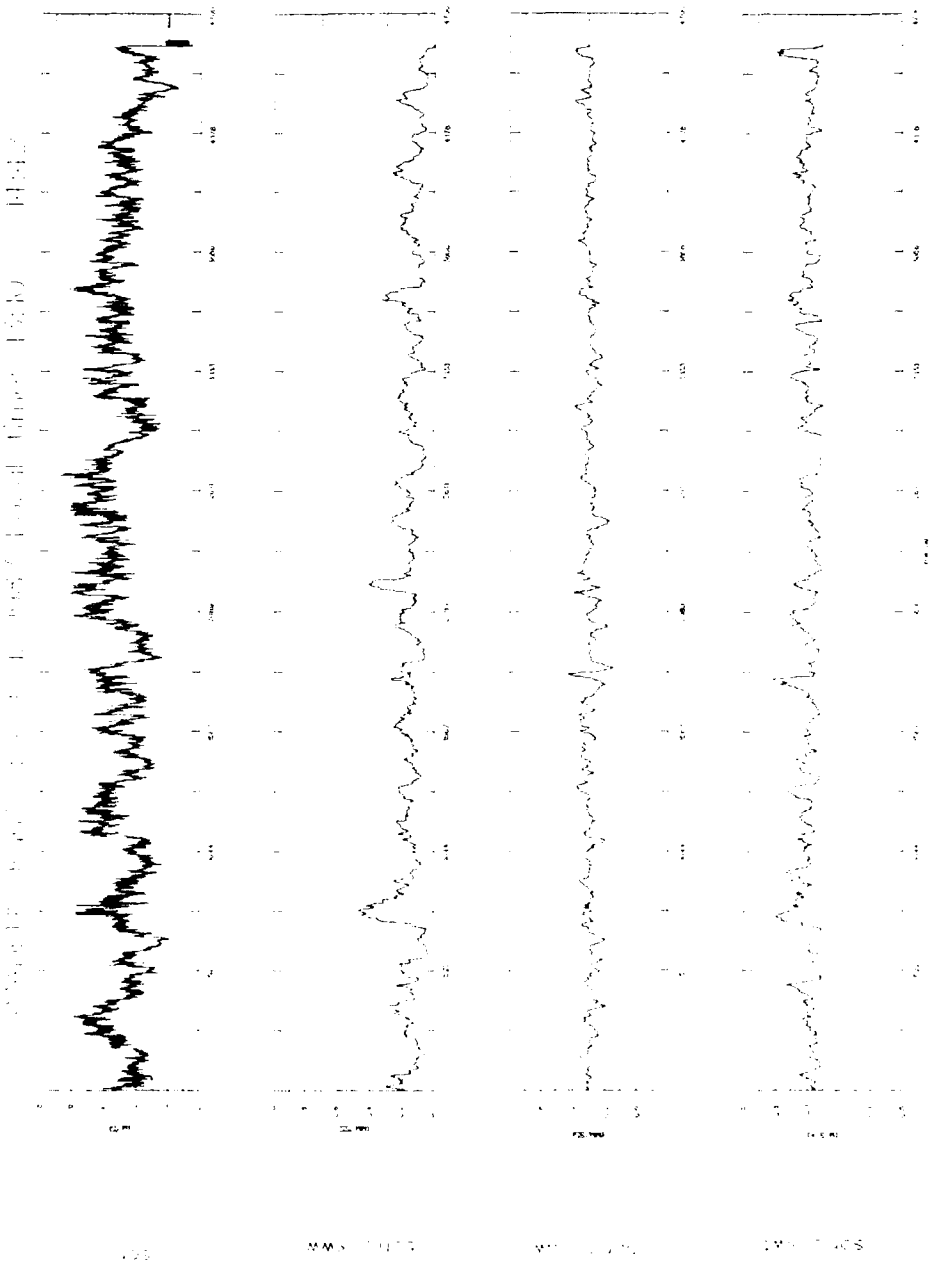

Figure 43. Wind speed (u) and 1-min running mean statistics of vertical variance (ww), shear stress (uw), and (sensible) heat flux (wt)

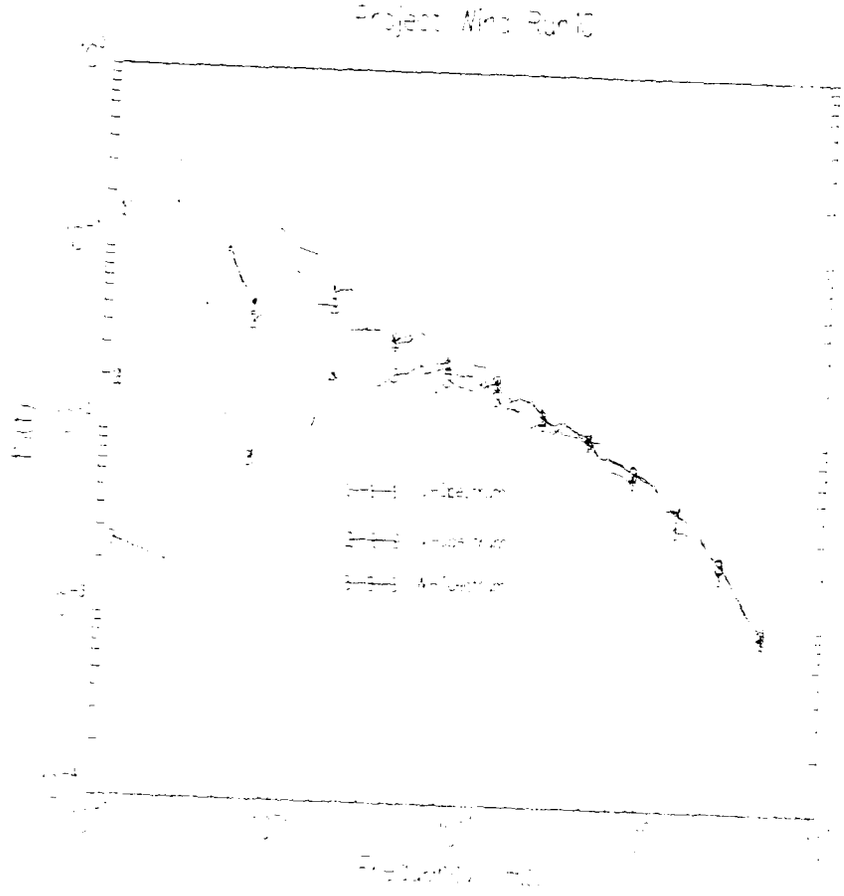

Figure 44: u, v and w-spectra for Run # 10.

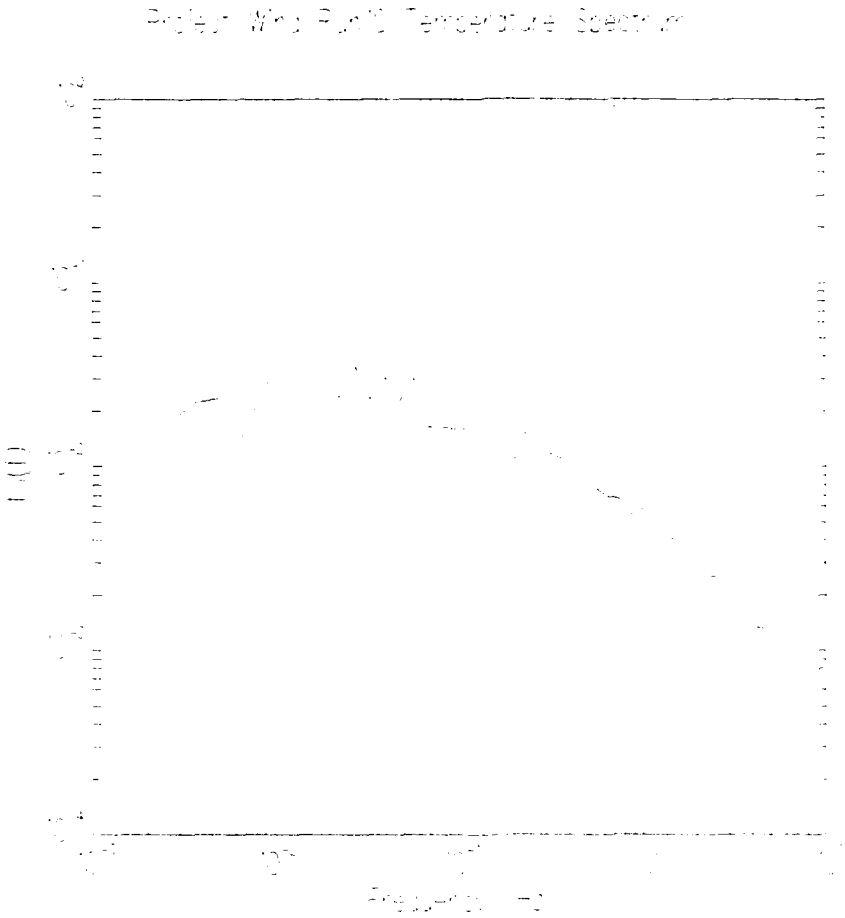

Figure 45: Temperature spectrum for Run # 10.

4.11 Run # 11, 2 October, Overview

Speed: 2.38 cm/s	(15/16)	(max 8 hrs)	AMADEUS 1987 Sonic Spectra			
ch 1 (u) 10 m/s	ch 2 (v) 10 m/s	ch 3 (w) 2 m/s	ch 5 (T) 5°C /Volt			
FM - tape	Date		Start	Stop	Duration	Spectra
# 11	02 Oct		06:40	13:20	6 hrs 40 min	06:40 - 08:12

Run # 11

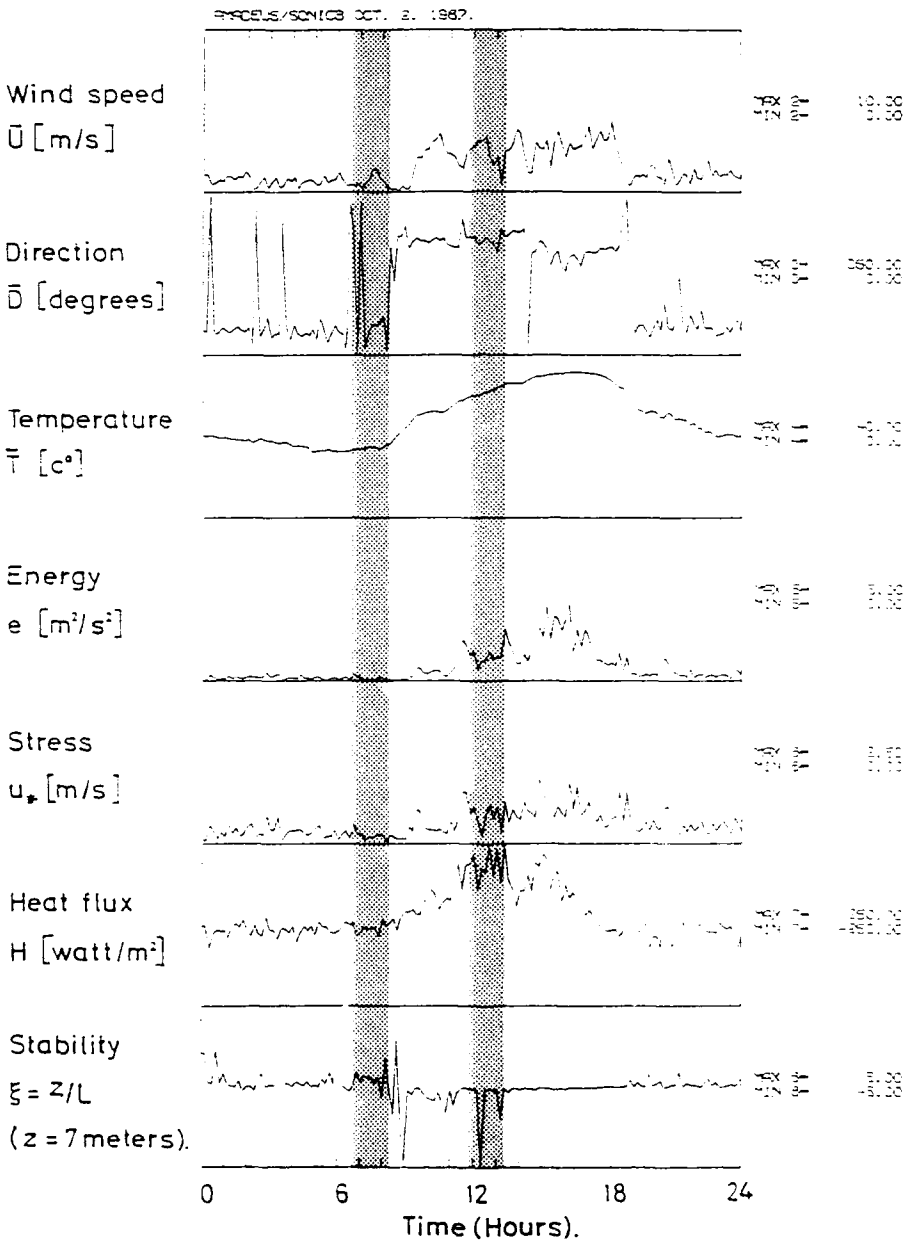

Figure 46: 10-min mean values for Run # 11.

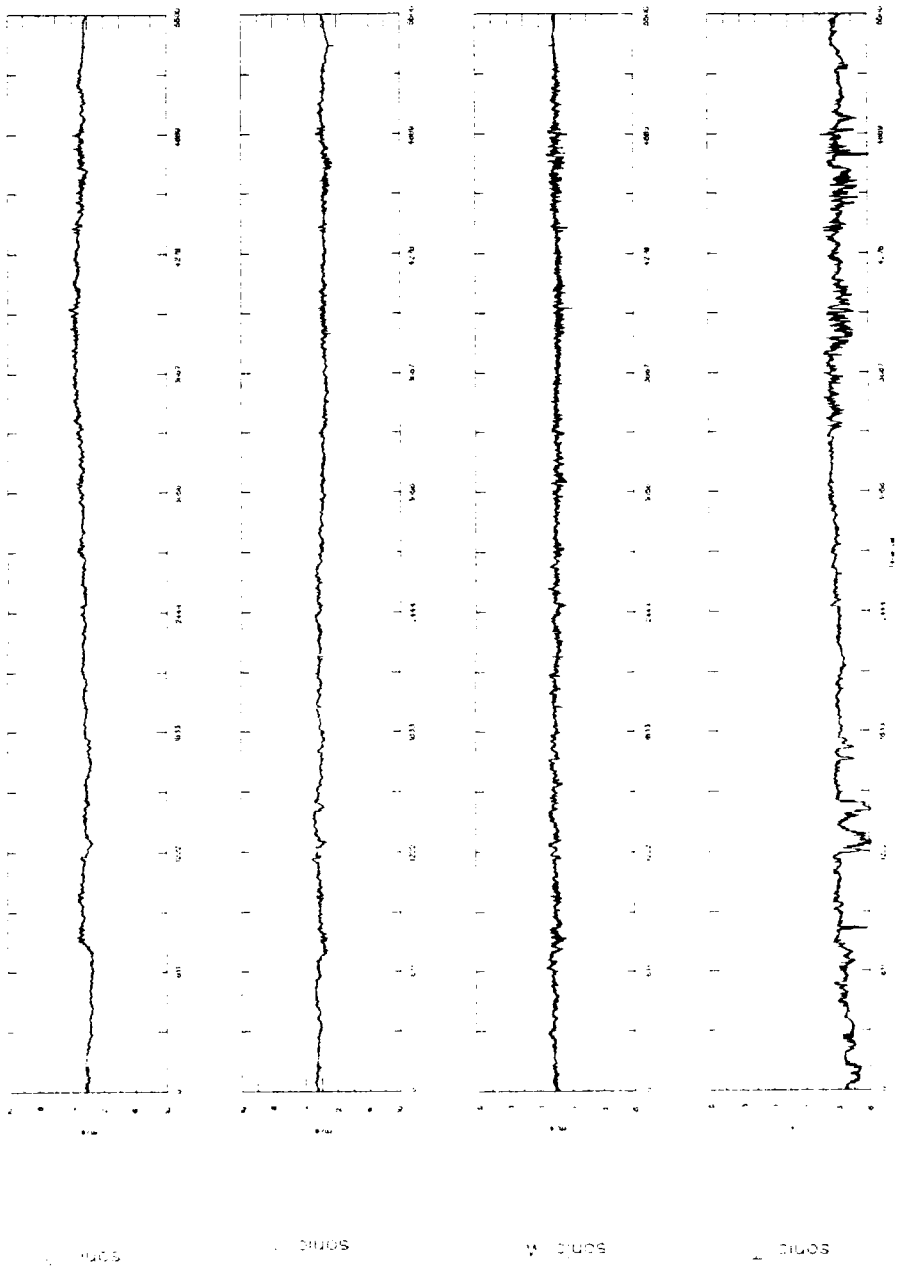

Figure 47: Sonic time series.

Table 11. Mean statistics for time series.

	Statistics from 55200 samples							
Mean	u :	0.595	v :	-0.000	w :	-0.000		
Covariance	uu	0.32234	uv :	-0.12716	uw :	-0.05746	uT :	0.12393
			vv :	0.17327	vw :	0.02296	vT :	-0.05048
					ww :	0.02853	wT :	-0.02794
							TT :	0.20264

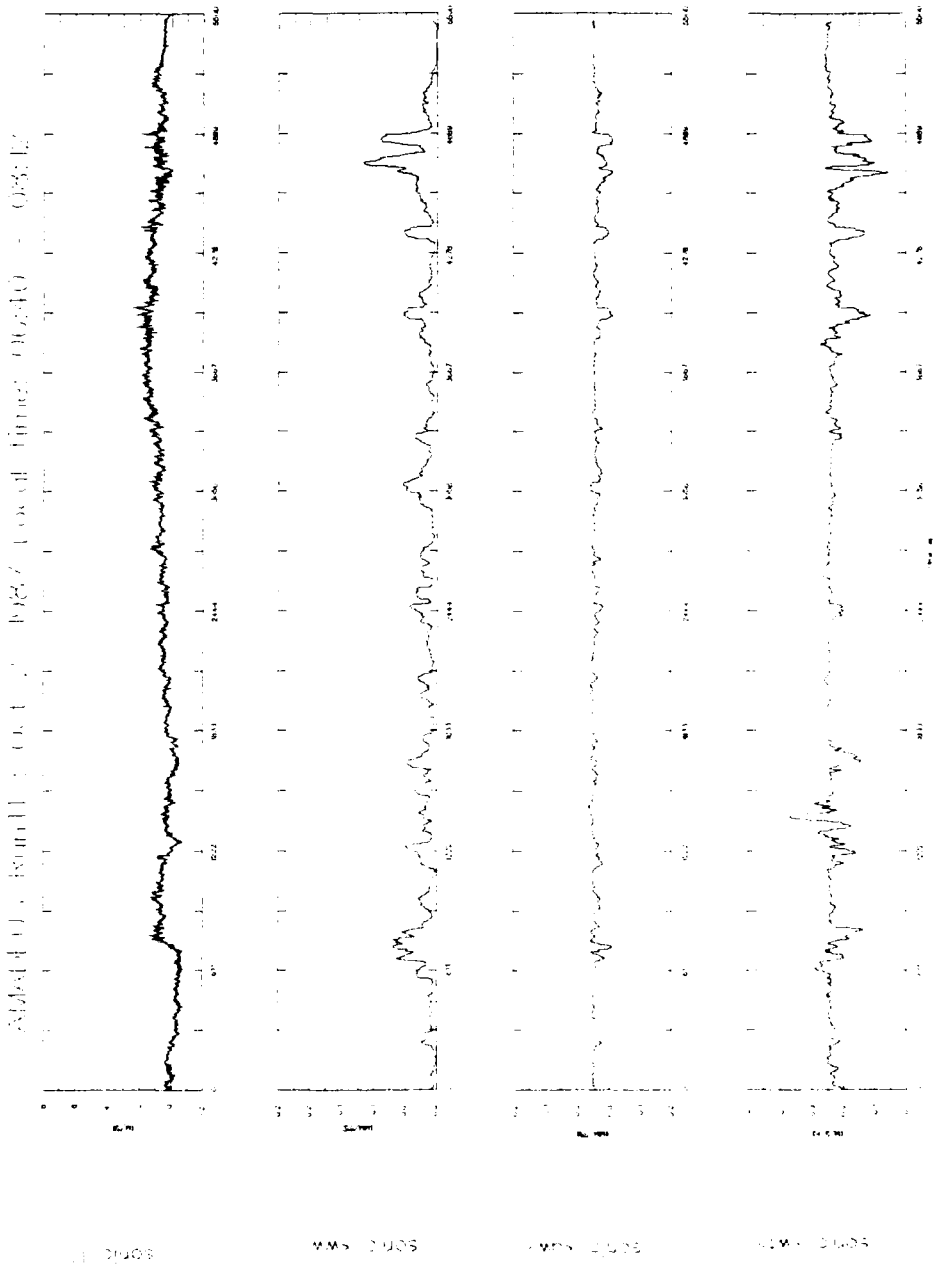

Figure 48: Wind speed (u) and 1-min running mean statistics of vertical variance (ww), shear stress (uw), and (sensible) heat flux (wt).

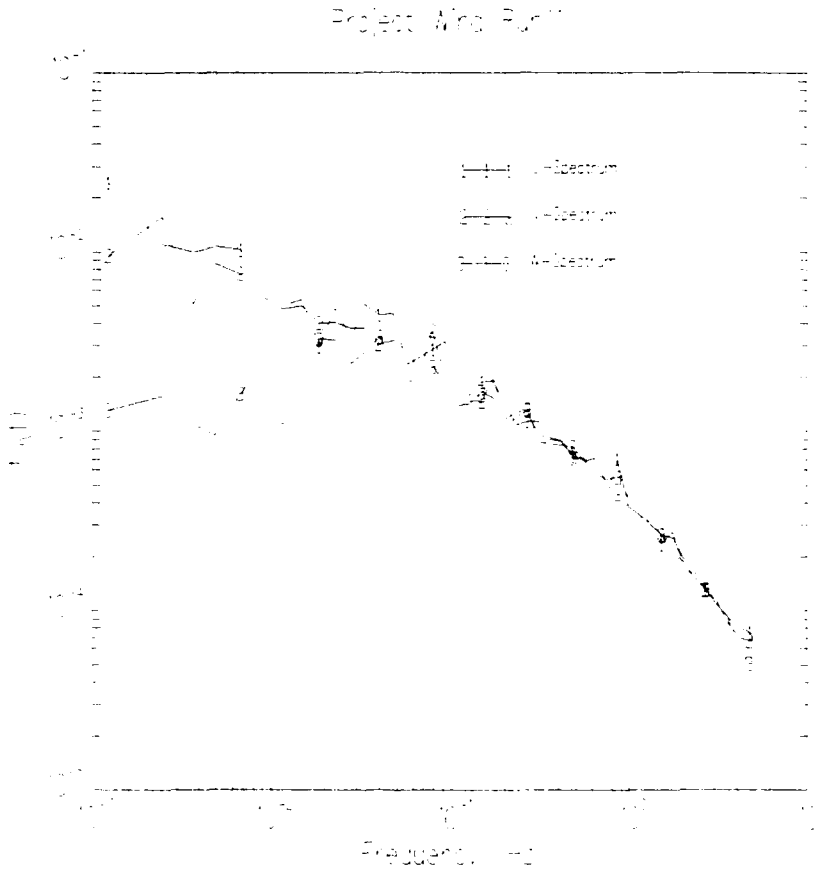

Figure 49: u, v and w-spectra for Run # 11.

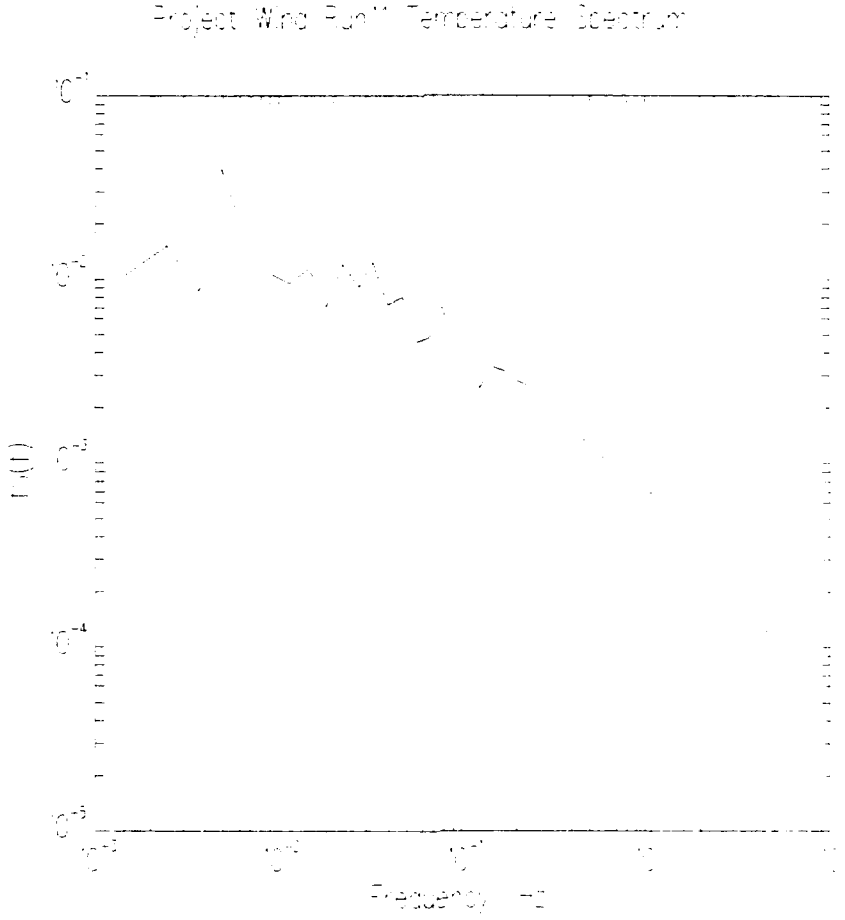

Figure 50: Temperature spectrum for Run # 11.

4.12 Run # 12, 2 October, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1 (u) 10 m/s	ch 2 (v) 10 m/s	ch 3 (w) 2 m/s	ch 5 (T) 5°C /Volt				
FM - tape		Date		Start	Stop	Duration	Spectra
# 12		02 Oct		06:40	13:20	6 hrs 40 min	11:48 - 13:20

Run # 12

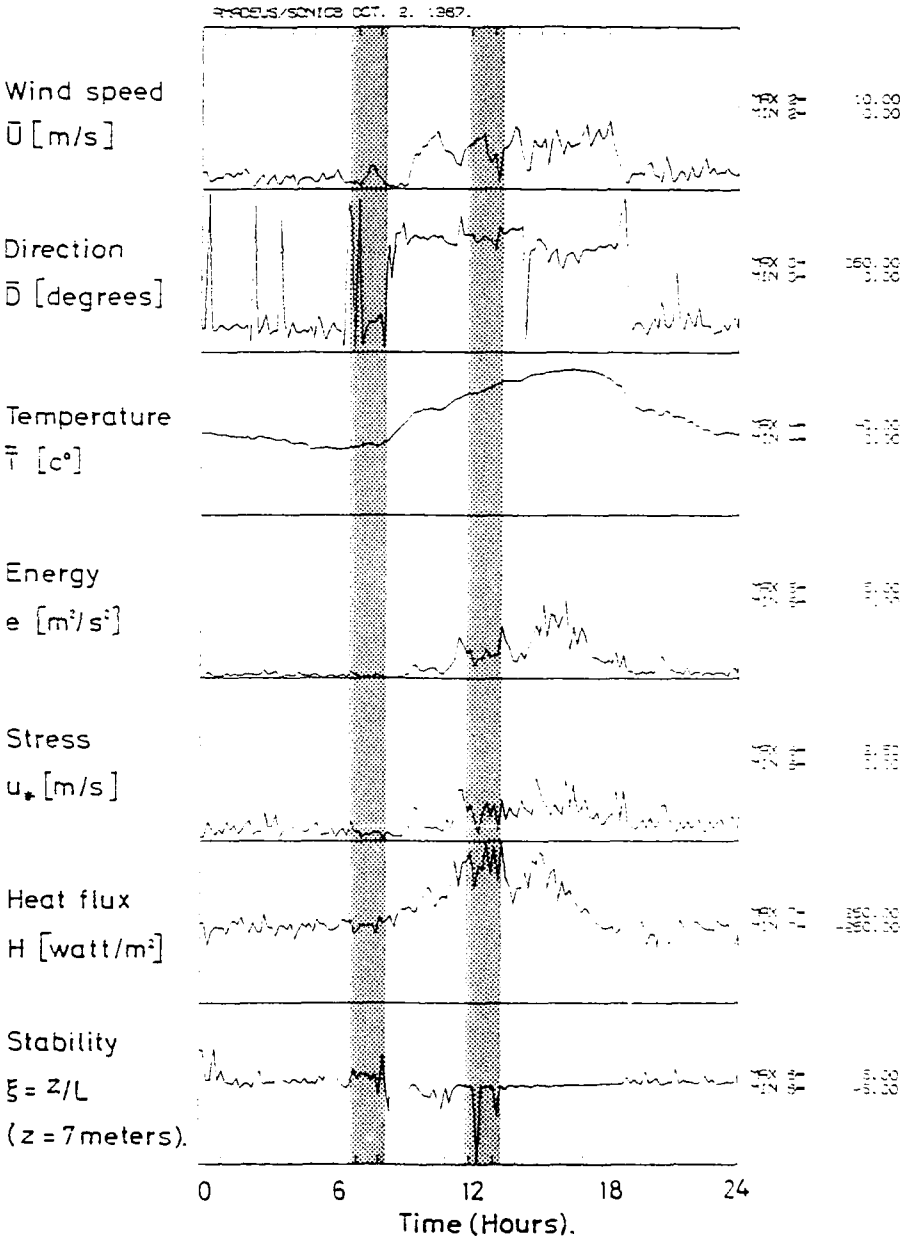

Figure 51. 10-min mean values for Run # 12.

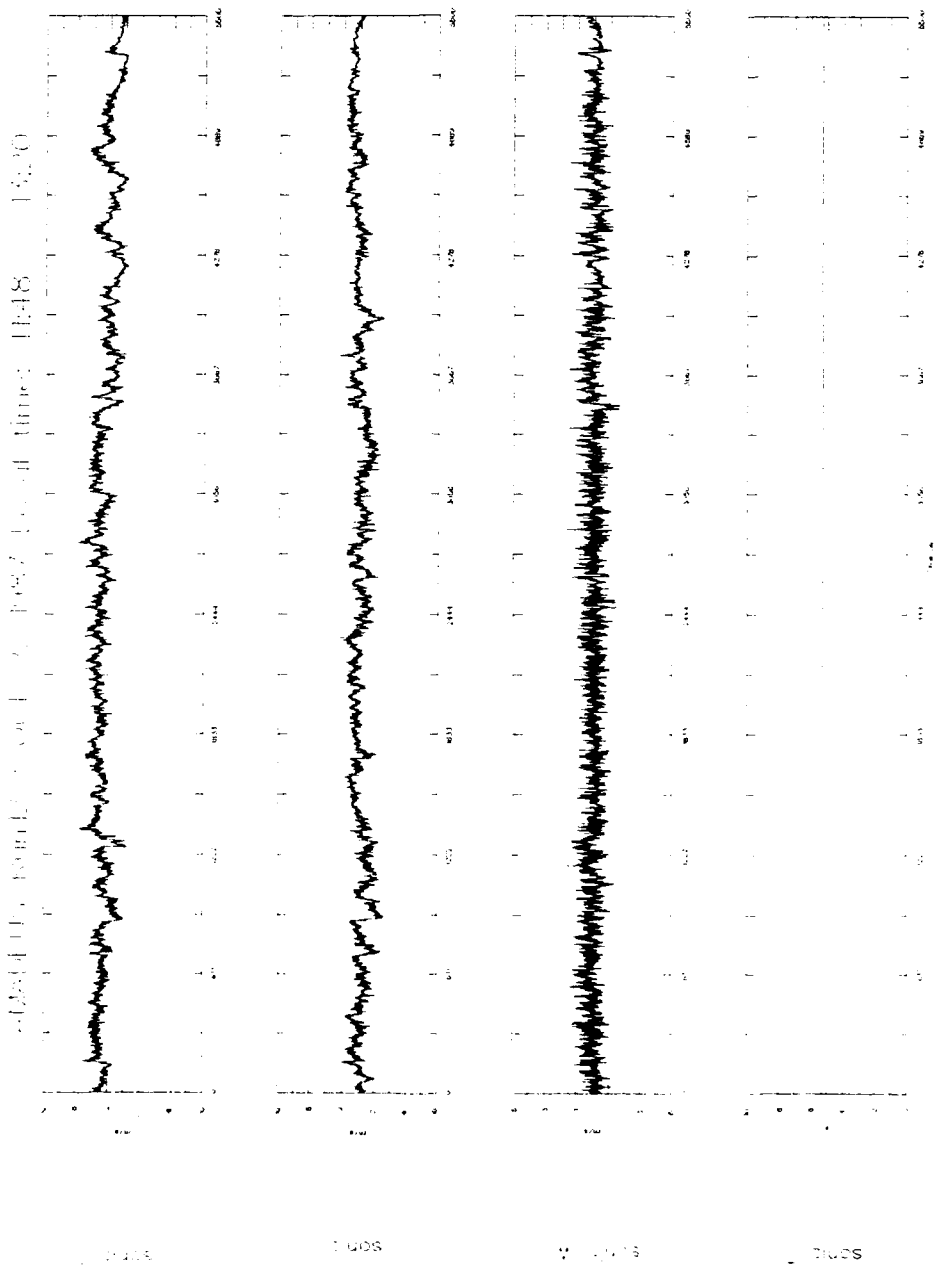

Figure 52: Sonic time series.

Table 12. Mean statistics for time series.

	Statistics from 55200 samples							
Mean	u :	2.517	v :	0.000	w :	-0.000		
Covariance	uu	1.14982	uv :	-0.17054	uw :	-0.03422	uT :	
			vv :	0.74869	vw :	0.00086	vT :	
					ww :	0.15994	wT :	
							TT :	

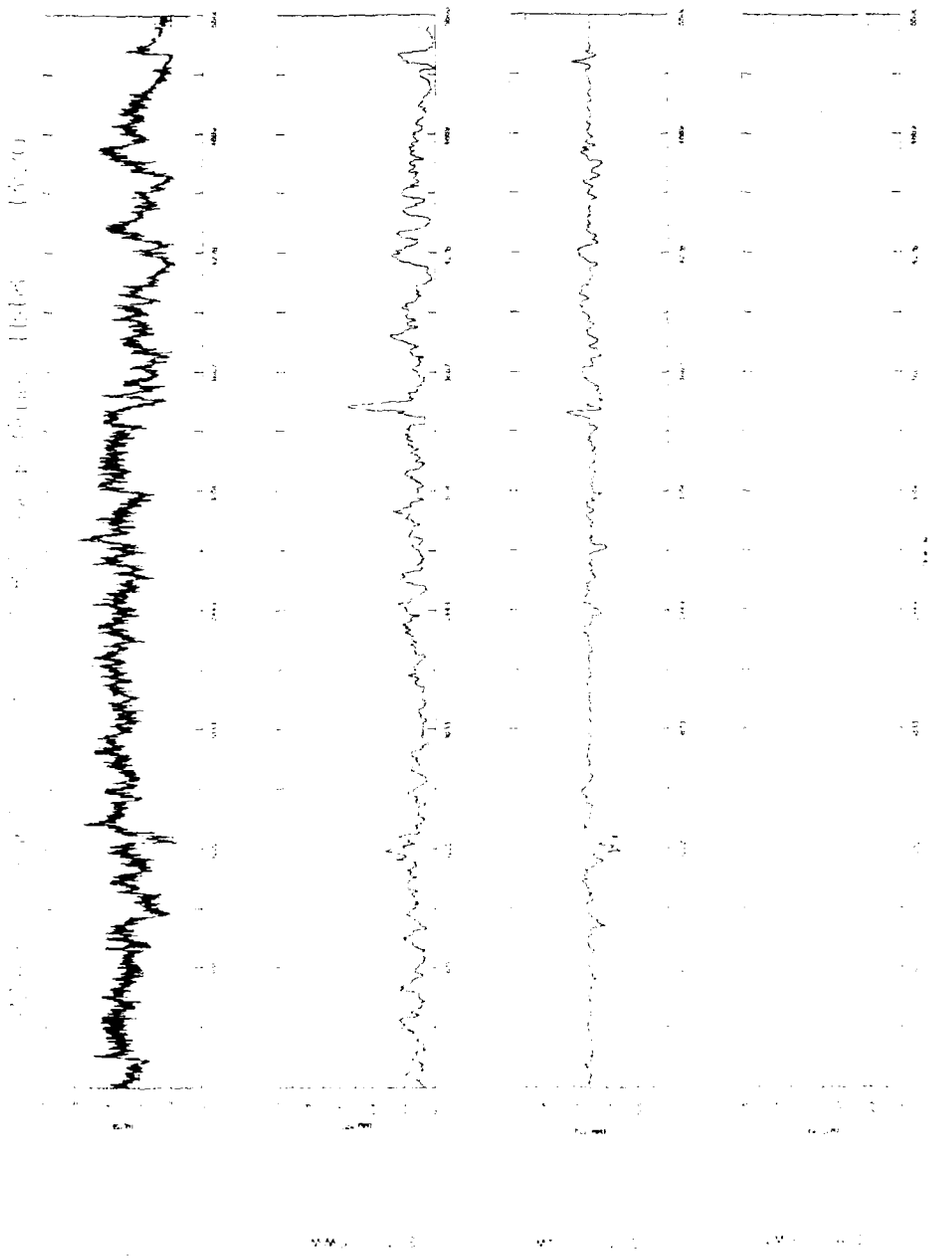

Figure 53. Wind speed (u) and 5-min running mean statistics of vertical variance (σ_w^2), shear stress ($\overline{uw}$), and (sensible) heat flux ($\overline{wt}$)

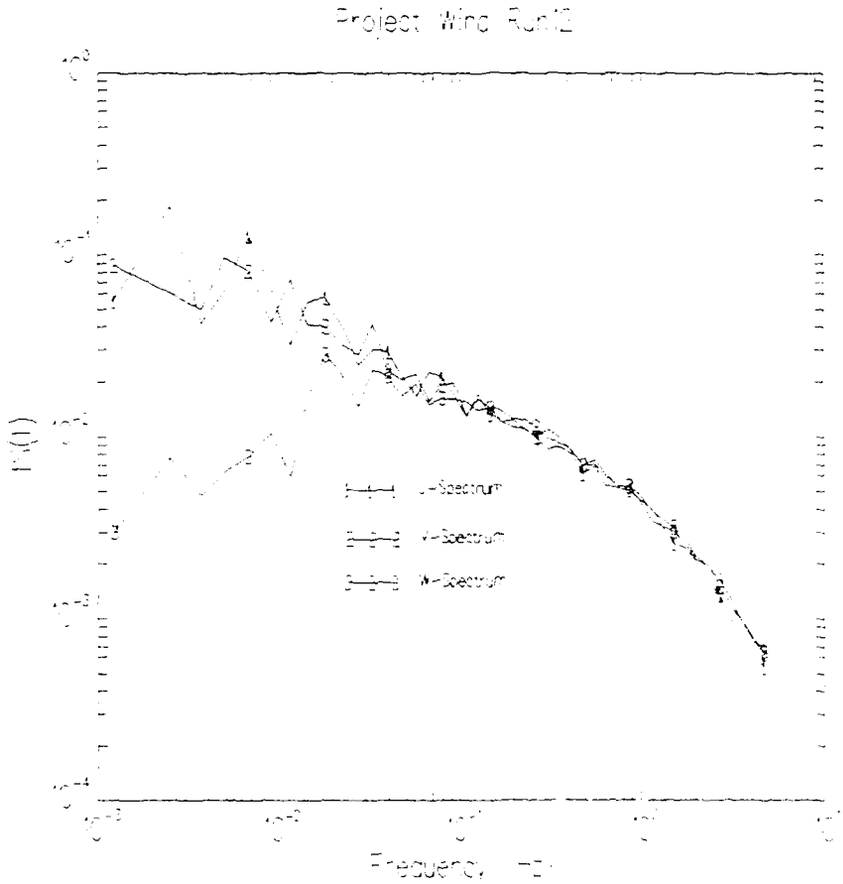

Figure 54: u, v and w-spectra for Run # 12.

Figure 55: Temperature spectrum for Run # 12.

4.13 Run # 13, 3 October, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1	ch 2	ch 3	ch 5				
(u)	(v)	(w)	(T)				
10 m/s	10 m/s	2 m/s	5°C /Volt				
FM - tape		Date		Start	Stop	Duration	Spectra
# 13		03 Oct		06:40	12:34	5 hrs 54 min	06:40 - 08:12

Run # 13

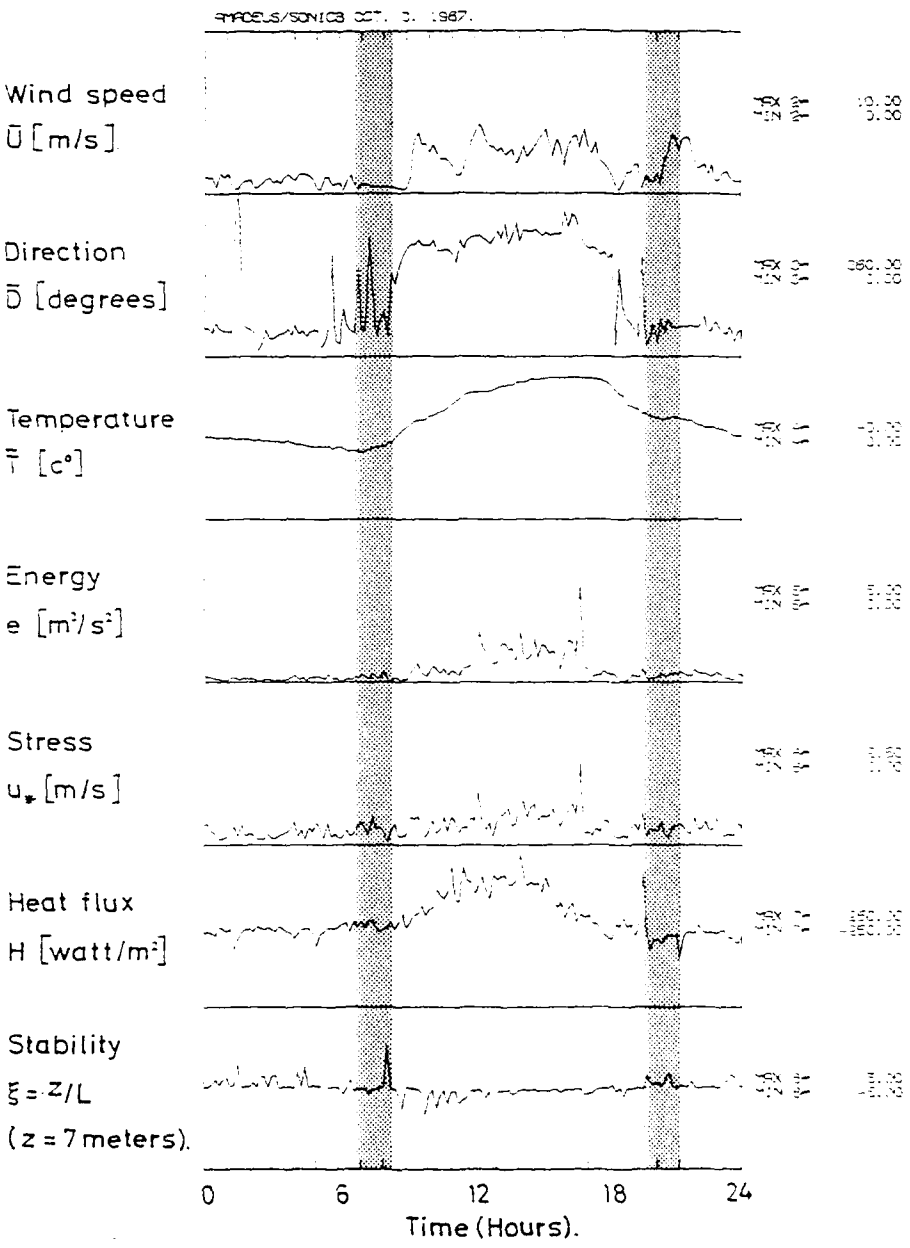

Figure 56: 10-min mean values for Run # 13.

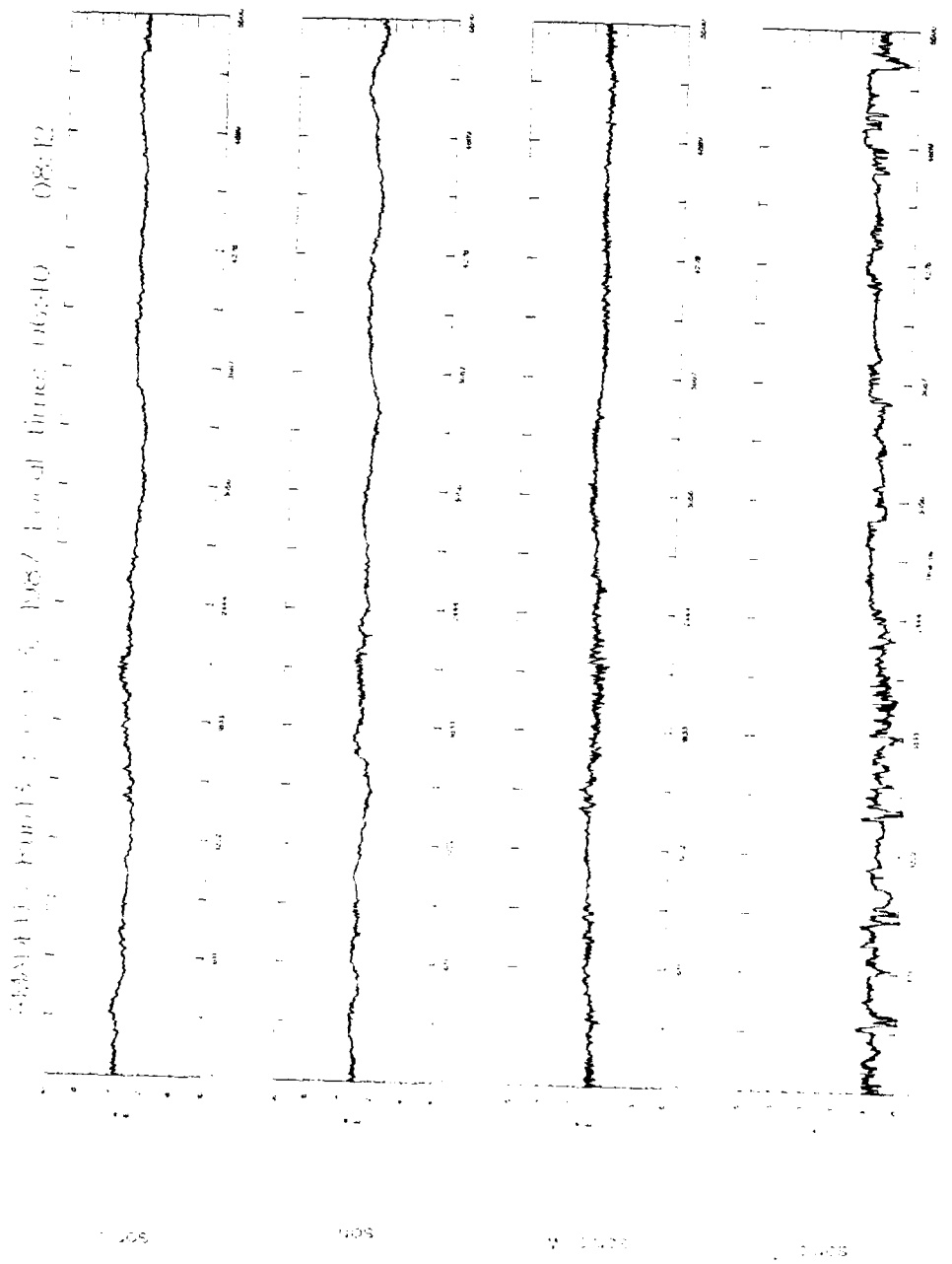

Figure 57. Sonic time series

Table 13. Mean statistics for time series.

	Statistics from 55200 samples							
Mean	u :	0.342	v :	0.000	w :	-0.000		
Covariance	uu	0.26082	uv :	0.12192	uw :	-0.08745	uT :	0.00532
			vv :	0.23956	vw :	-0.04410	vT :	0.01807
					ww :	0.04488	wT :	-0.00987
							TT :	0.43748

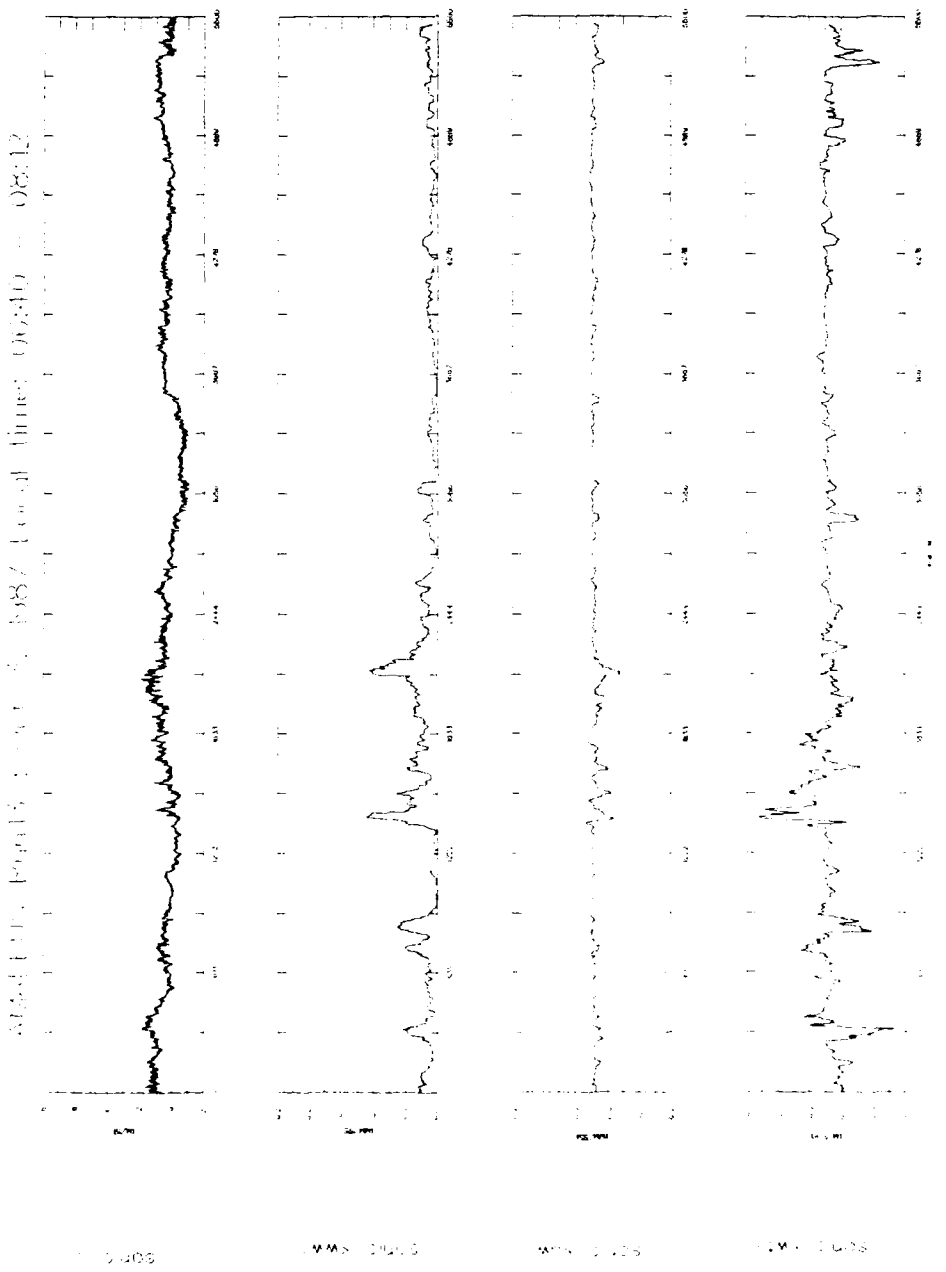

Figure 58. Wind speed (u) and 1-min running mean statistics of vertical variance (ww), shear stress (uw), and (sensible) heat flux (wt).

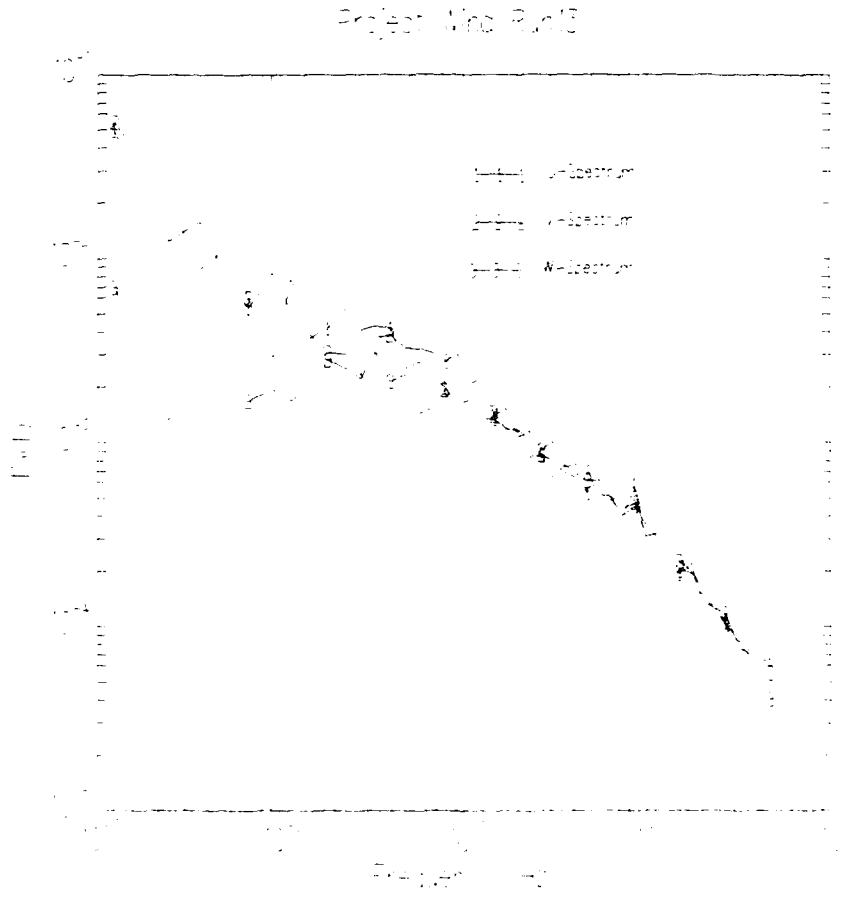

Figure 59: u, v and w-spectra for Run # 13

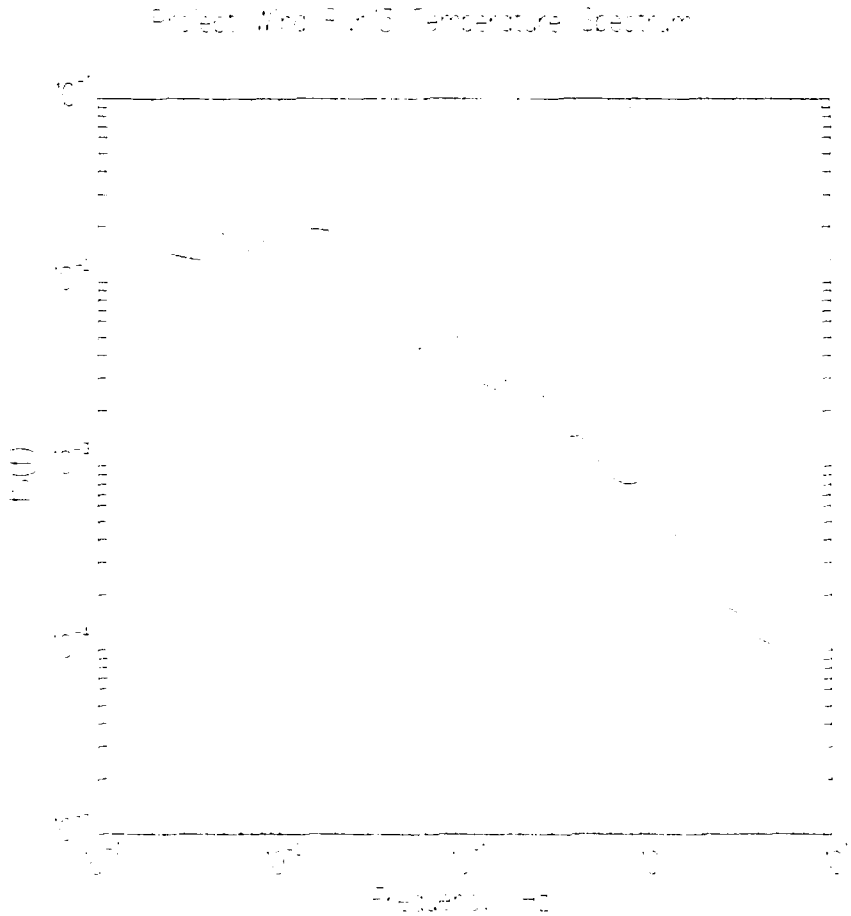

Figure 60: Temperature spectrum for Run # 13

4.14 Run # 14, 3 October, Overview

Speed: 2.38 cm/s (15/16) (max 8 hrs)				AMADEUS 1987 Sonic Spectra			
ch 1 (u) 10 m/s	ch 2 (v) 10 m/s	ch 3 (w) 2 m/s	ch 5 (T) 5°C /Volt				
FM - tape		Date		Start	Stop	Duration	Spectra
# 14		03 Oct		14:10	22:18	8 hrs 08 min	19:30 - 21:02

Run # 14

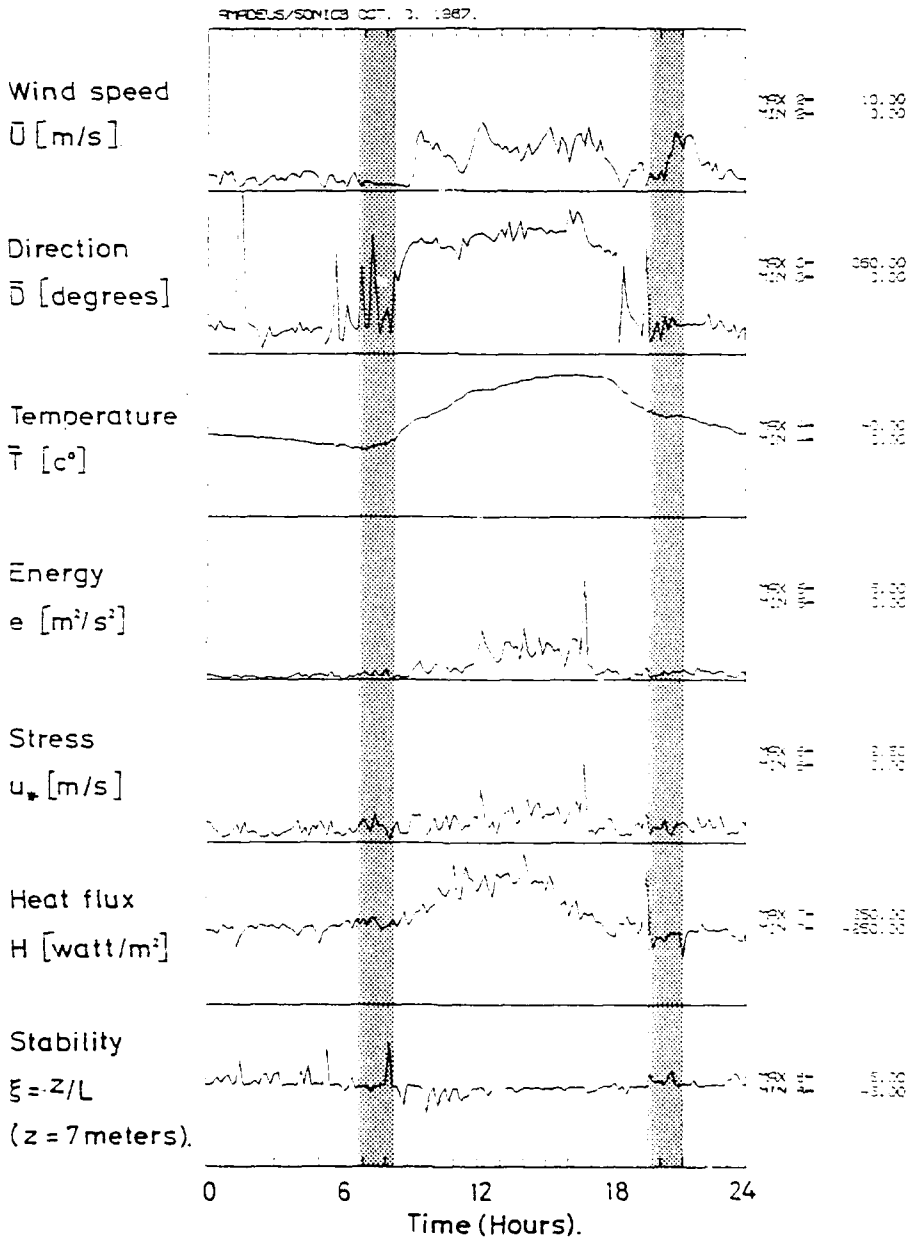

Figure 71: 10-min mean values for Run # 14.

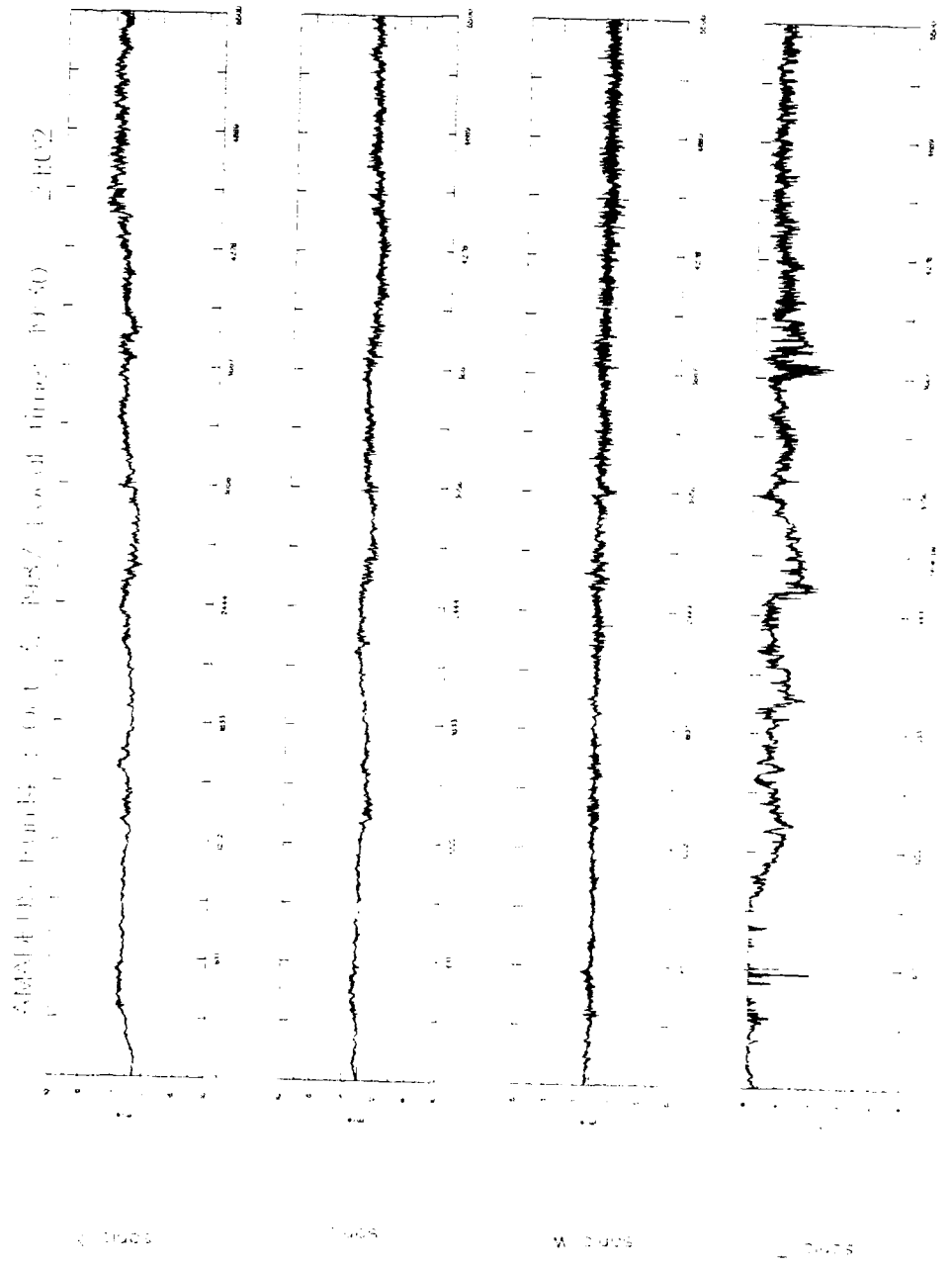

Figure 72: Sonic time series.

Table 14. Mean statistics for time series.

	Statistics from 55200 samples							
Mean	u :	1.428	v :	-0.000	w :	0.000		
Covariance	uu	1.45057	uv :	-0.16128	uw :	0.14896	uT :	-0.00325
			vv :	0.31301	vw :	0.02117	vT :	0.15441
					ww :	0.04872	wT :	-0.01533
							TT :	0.50053

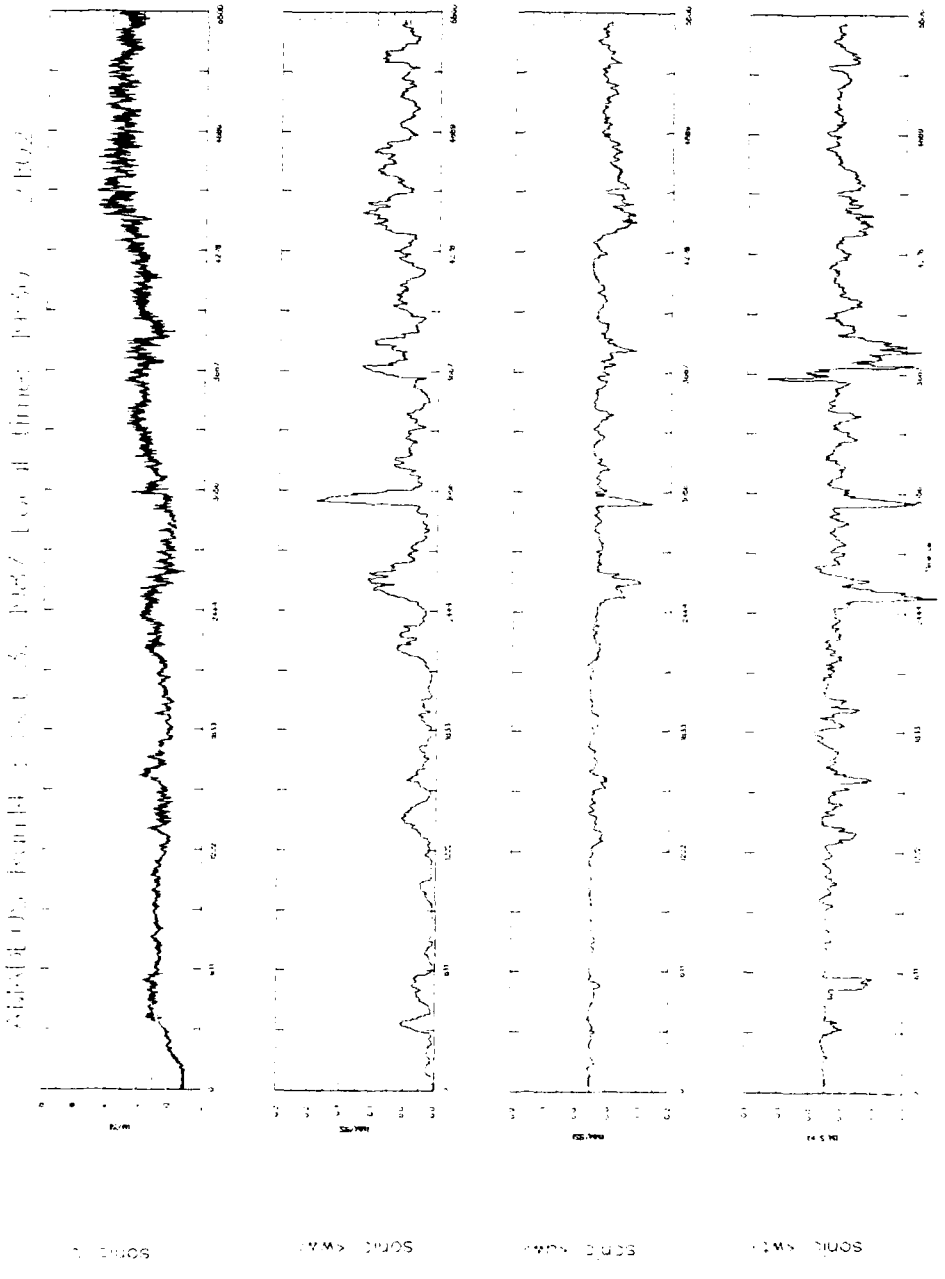

Figure 79: Wind speed (u) and 1-min running mean statistics of vertical variance (ww), shear stress (uw), and (sensible) heat flux (wt).

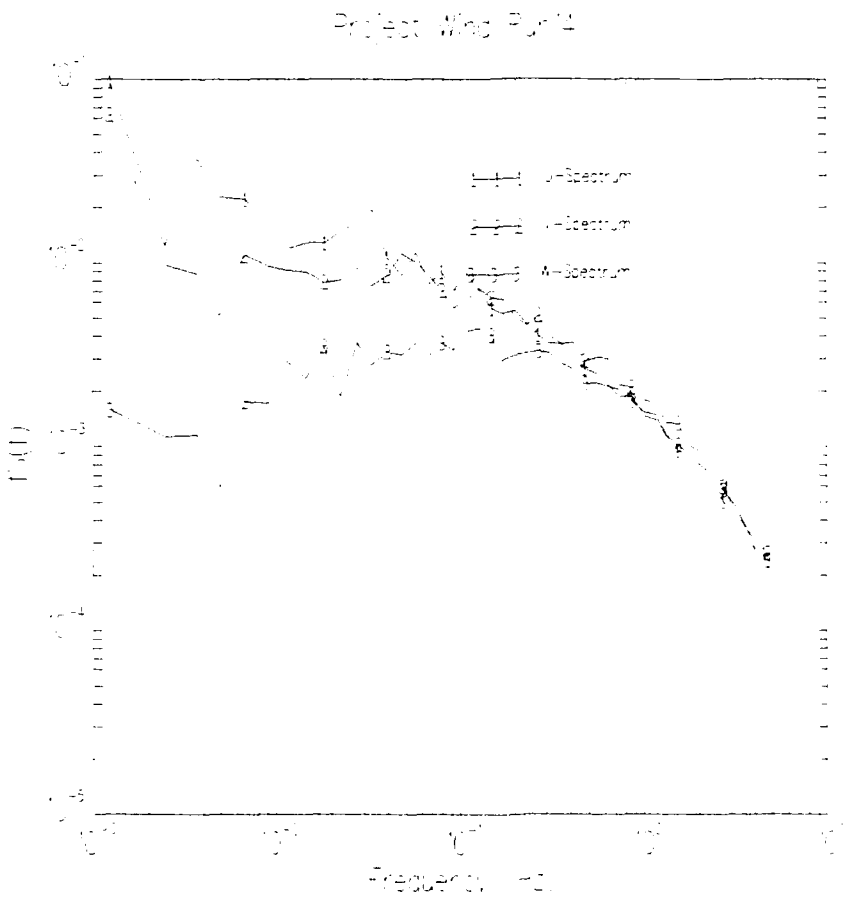

Figure 74: u, v and w-spectra for Run # 14.

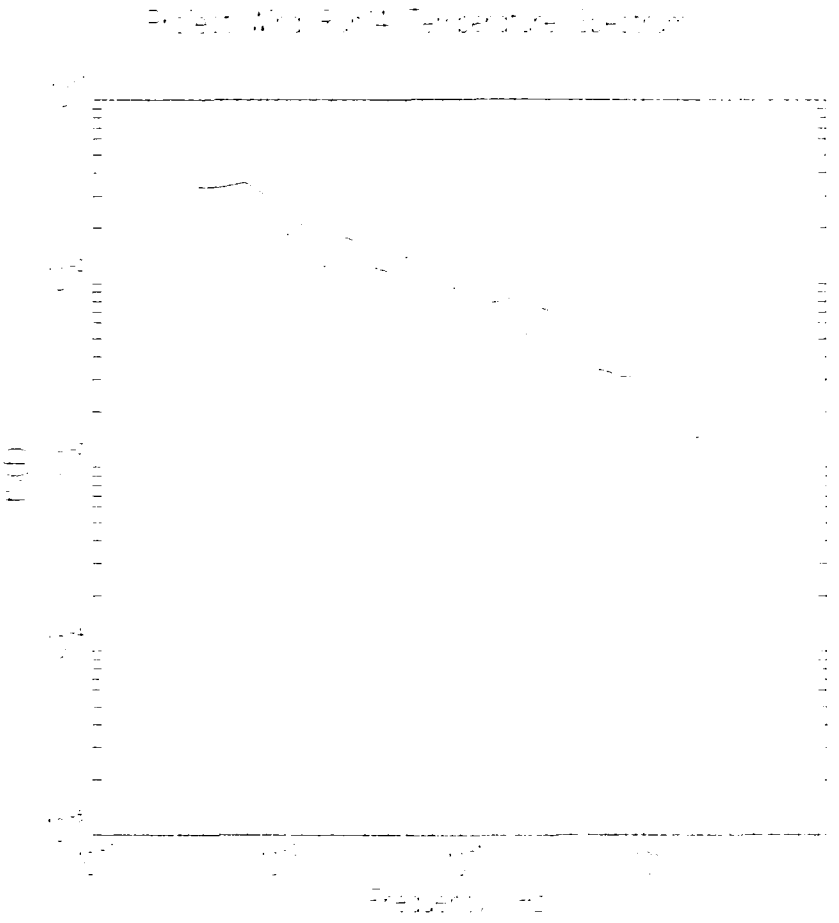

Figure 75: Temperature spectrum for Run # 14.

References

Mikkelsen, T., Hansen, A., Eckman, R.M. and Thykier-Nielsen, S. (1989). Project *WIND*, Phase IV, Dispersion Study: Aerial Smoke Plume Observations and Surface-Layer Turbulence Measurements, Part I. Riso-M-2718.

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Project WIND, Phase IV, Dispersion Study: AMADEUS
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Part IV: Wind and Temperature Spectral Analysis

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Abstract (Max. 2000 char.)

This data report contains results from selected spectral analyses of the turbulent wind and temperature measurements performed by Risø National Laboratory during the AMADEUS "Smoke and Diffusion Tests" of Project WIND, Phase IV, which took place as a cooperative research oriented study between the U.S. Army Atmospheric Sciences Laboratory (ASL) and U.S. Department of Agricultural Forest Service (USDAFS) in the Meadow Brook Valley near Read Bluff, California, during the period between 3 September and 7 October 1987.

In Part I of this study (Risø- M-2718, January 1989), Risø National Laboratory reported sonic-anemometer measurements of 10-min averaged surface-layer scaling parameters such as surface heat flux, shear stress, turbulence levels and atmospheric stability measured at two locations in the Meadow Brook Valley floor accompanied by aerial photography of the valley-floor smoke puff and plume spread.

The present study (Risø-M-2861) provides time series plots of the turbulent (10 Hz block-averaged) wind and temperature signals as recorded by sonic-anemometers/thermometers at the 7-m level above the Meadow Brook Valley floor during the AMADEUS trials. The time series are further processed into energy spectra for the three wind components (u', v', w') and fluctuating temperature (T') and here presented together with their relevant scaling parameters calculated by the correlation method.

The time series and spectra provide flow and diffusion modellers of the AMADEUS experiments with an insight in the turbulent scales and energies most responsible for the observed flow and diffusion processes. Furthermore they provide high-resolution boundary-layer flow and turbulence measurements for model simulation of the individual experiments.

All data have been transferred to ALS on IBM PC-compatible diskettes.

Descriptors INIS/EDB

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